OUR FORESTS

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Preface

This is not a book on the science of forestry—a subject on which considerable literature exists in English, German, French and other European languages. The book is about our forests and is primarily meant to acquaint the reader with what they are, how they serve mankind and what would happen if they are allowed to disappear and how the processes of rapid deforestation and denudation of our country can be arrested and hopefully reversed. It also attempts to enlighten the reader about the role that the Forest Departments of this country have been playing for the last century and a quarter in conserving the country's forest wealth.

Unfortunately there is a great deal of ignorance in the common mind about the role that the Forest Department, one of the country's oldest departments which was established as far back as 1856, has been playing for more than a century and continues to play with even greater vigour at the present time. The main reason is that the forest department is by tradition a silent department not given to blowing its own trumpet. The forests are situated in remote and often inaccessible areas and consequently the work being done there does not meet the public eye. By virtue of the isolated life that he leads, the forester develops an insular attitude and is seldom given to talking or writing about the work that he does and the service he renders to the country. Spectacular and newsworthy events are not a common occurrence in the field of forestry nor can forests be established in a matter of months and years. It takes decades and in some cases even a century of hard, patient and scientific work to get a fine stand of forest established. Compared to the human lifespan the time frame for trees to grow and mature is much larger and

therefore all planning has to be made with an eye on the distant future rather than the immediate present. The trees that are felled today are not the earnings of the present generation but those of the past and the forests planted today will require careful management for the next 50 to 100 years before the future generation can harvest them. Unlike manmade projects mistakes of omission and commission do not show in the course of a few years but only after many many decades. The forest has a capacity to absorb human mistakes for a much longer period than manmade structures and therein lies the seed of its destruction. A leak in a dam or a crack in a structure shows up immediately and can be repaired overnight. But a flaw in the management of a forest cannot be detected immediately except by those trained in forestry and its ill effects may take several decades before they are evident. It may take many decades more to repair the damage. It is, therefore, essential that the management of forests should be left to those who are trained in the art.

It is a matter of great satisfaction that public opinion has of late been greatly aroused regarding the destruction of our forests and environment, thanks to the concern expressed by our Prime Minister. It must be remembered that the situation that is obtaining now has not developed overnight but has been in the making for the last 30 years or more.

The forest departments have been conscious of this erosion in forest conservation all through and have almost at all stages protested against the forces responsible for it. It is not realised that if the forest department opposes deforestation of a forest area for any purpose, it does so not to harass the people of today but for their long-term benefit and for the benefit of generations yet unborn. One has to be patient to reap the fruits of forestry. The concept of social forestry is spreading fast and both the Central and State Governments are giving it due importance. International Organisations such as the World Bank and some developed countries are pouring in substantial financial aid but the sucess of this operation will basically depend how well the

plantations raised with so much money and labour are looked after by the local people till they are ready for harvesting. The species planted under social forestry should be carefully chosen and should essentially be of short rotation not exceeding 15 years. It would be too much to ask our village people to wait longer. Hopefully our future generations will learn to wait longer. like the people in Europe where most species take 80 years to mature. One word of warning. The increasing stress on social forestry should not be allowed to blur our vision regarding the protection and management of our existing forests. It must not be forgotten that most of them have been standing for the best part of a century. Reckless cutting of such forests and damaging them by uncontrolled grazing on the one hand and raising new plantations under social forestry on the other would be deluding ourselves and robbing future generations of their heritage.

I have to acknowledge my gratitude to the President, Forest Research Institute & Colleges and in particular to Shri S. K. Shukla, Publicity & Liaision Officer of that Institute for supplying most of the photographs used in this book. I have also to place on record my gratitude to the late Sri H. G. Champion and the late Shri S. K. Seth for reproducing the information on forest types from their monumental publication "Forest Types of India".

B. P. SRIVASTAVA

Contents

Chapter I

INTRODUCTION

This book is about forests—what they are, what benefits they shower on mankind, what has happened to areas of the earth where forests have disappeared and what would happen to mankind if the forests were allowed to disappear completely.

The love of forests is an atavistic instinct in every human being because long long back, the home of the human race was in the forest, which covered a major portion of the earth's land surface. It provided him with shelter and food and all that he needed for survival. He lived in trees and could travel from tree to tree by swinging along the branches. Mothers left little babies hanging from branches while they went about their work. That is why babies even today have a surprisingly strong grip.

But as human civilisation advanced man learnt to cultivate certains pecies of plants and grasses for food crops and domesticated certain species of animals and birds which provided him with meat, milk and eggs. The areas of the earth which had a more equable climate were colonised first and such forests as existed were gradually converted into cultivation or pasture lands. These became the cradles of ancient civilisations.

As the centuries went by and man became more and more civilised, he started living in villages, towns and cities, all carved out from lands which were once covered with thick forests. Thus the boundaries of the forests receded in direct proportion to the degree of civilisation achieved by people.

With the rapid advancement in medical sciences, and improvement in public health and hygiene combined with the disappearance of frequent internecine warfare between countries or within each country, the world population has been steadily increasing in the 20th century. Consequently, the forest cover is being relentlessly destroyed. In many countries, including our own, the existence of forests has reached a critical stage and there is just not sufficient forest cover to protect the environment or to meet the ever increasing needs for forest materials.

It is not often realised that the existence of forests on the earth's surface is absolutely essential for the well-being of the human race and if they disappear altogether the very existence of mankind may be in danger. The large desert areas of the world which once upon a time carried forests, are a living proof of this fact. During the excavation of the ancient city of Mohenjodaro some charcoal was discovered which on examination was found to be of rosewood, a tropical deciduous species occurring only in high rainfall areas. The fact that rosewood was being used by the people of Mohenjodaro as fuel goes to show that it must have been available in plenty, and the area which is now a total desert must have been covered with lush vegetation.

In fact, civilisations which once bloomed from the Indian subcontinent to the Mediterranean coast of North Africa died because they denuded the land that supported them and in the process left behind a belt of deserts which now stretch from Rajasthan through Sindh, Baluchistan, Iran, Iraq, Arabia, Syria, Palestine and Egypt to Tunisia and Morocco. It is rightly said that forests precede civilisations and deserts follow them.

It is ironical that while the very existence of mankind is dependent on the existence of adequate forest cover, it is man alone who is the greatest enemy of forests. At the same time he can also be the greatest preserver. It is in the hands of the men, women and children of today to ensure that the earth's depleting forest cover is preserved for their sake and for the sake of their children for all times to come.

Chapter II

IN THE SERVICE OF MAN

Why are forests essential and how is the well-being of mankind closely linked with them? It is common knowledge that forests protect the soil from erosion by wind and water. Soil is formed through the slow weathering of rocks by sun and rain over centuries. Alternate heating and cooling by the sun's rays causes the rock to crack and crumble. When the rains come they also cause the rocks to break down into soil particles. The process is very slow and in the course of several centuries the top surface of the rocks gets converted into soil. It is estimated that it takes Nature about 1000 years to produce only 2.5 centimetres of soil. One can imagine how many tens of thousands of years it must have taken Nature to form the thick layers of soil that covers our land. It is not often realised that, of all the natural resources, the most valuable and basic is soil. Though it is renewable, its formation is so slow compared with the human time span that for all practical purposes it may be considered as a non-renewable resource which once lost is lost forever.

Trees and forests protect the soil by providing shade which prevents the soil from becoming too dry and friable during the summer season. The crowns of the trees also reduce the velocity of the rain drops striking the soil which reduces the dislodging of the soil particles, and finally the root system of trees and bushes holds the soil firmly. Once the vegetal cover consisting of trees, bushes or grass is removed soil erosion starts at

an accelerated pace particularly on sloping lands. The soil cover accumulated over tens of thousands of years can get washed away in a few hours' time, exposing the bed-rock which produces nothing.

Apart from protecting the soil, forests also improve the quality of the soil by increasing its porosity. Leaf and other organic matter falling from the trees rot and mix with the soil to form humus. Soils containing humus are very fertile. They also can absorb large quantities of water. The soil under forest cover acts like a giant sponge which can absorb and hold the water that falls during the rainy season and lets it sink deep into the soil instead of letting it flow away or evaporate, thereby guaranteeing a perennial supply of sub-soil water in wells and springs.

A sponge can absorb water and remain wet while the water keeps dripping from it for a long time. A hard surface does not absorb water. For instance, if water were thrown on a cemented floor it will not get absorbed but will be there till it evaporates or if there is a slope it will flow down the slope quickly. On the other hand if the same floor were covered with a carpet and water thrown on it, most of the water will get absorbed by the carpet which will remain moist for a very long time. A thick forest cover on a slope acts exactly like a carpet.

Mountain slopes covered with forests conserve the water that falls during the rainy season and allow it to flow in streams and rivers as well as in sub-soil springs in a regulated manner. If the slopes are bare the entire quantity of water falling on a catchment rushes down without any restriction and causes soil erosion in the upper reaches and floods down below. But once the rains are over, the water supply in the springs and rivers dries up and there is drought. It may sound surprising but floods and droughts are very closely connected and are the two faces of the same medal. Increased frequency of floods and droughts anywhere is a sure sign that the forest cover in that region has been severely depleted. In our country the severity and frequency of floods and droughts are noticeably increasing every

year. This is the direct result of serious deforestation in the Himalayan region in the north and the hilly regions elsewhere in the country.

Trees discharge another important function called transpiration. The roots of trees go deep into the soil and pull out the sub-soil moisture which travels through the stem to the branches and finally to the leaves. The leaves have tiny holes in them called stomata through which the water evaporates into the atmosphere. This is called transpiration. The tree thus not only helps to conserve water in the soil but also brings the sub-soil water back into the atmosphere. This increases the humidity of the atmosphere and that is why on a hot day it is always cooler and pleasanter inside the forest or a grove of trees than in the open. The increased humidity in the atmosphere reduces dryness and is, therefore, helpful to plants and animals during the hot dry season. It also helps to increase the local rainfall because the presence of a large quantity of moisture in the air helps to produce more rain when the necessary weather conditions occur.

Forests have been providing wood to mankind ever since man learned to cook and to live in the huts and houses. They also provide grass for thatching and for making ropes, nets and baskets. As man became more and more civilised his dependence on the forests increased. So much so that today there is no sphere of human existence where something or the other made from forest raw materials is not in use. In fact, whichever way you may look, in your home, your office or outside, you cannot help seeing something or the other which has been made from raw materials supplied by the forests.

But perhaps the most important service that trees render to mankind in these days of rapid urbanisation and industrialisation is the role they play in reducing atmospheric pollution. The leaves of trees absorb large quantities of carbon dioxide, a poisonous gas, from the atmosphere, and the green substance in the leaves called chlorophyll, manufactures food material for the tree in the presence of sunlight. In this process which is called photosynthesis, large quantities of pure oxygen are

released into the atmosphere. Trees thus absorb the poison from the atmosphere and release life-giving oxygen into it, and in the process manufacture useful products such as wood, bark, flowers and fruits.

Air pollution is increasing in the heavily populated towns and cities due to the presence of a large number of human beings, motor vehicles and factories. The only way to keep the air clean in such cities is to have a large number of trees in the shape of groves or parks, along roadsides and in the compounds of factories, schools, colleges and private houses.

Apart from being a local problem atmospheric pollution is becoming a serious global problem which, if not checked, can cause serious climatic changes which might affect the existence of life on our earth. Scientists fear that if the carbon dioxide content in the atmosphere keeps increasing, a time may come when a thick layer of the gas will surround the upper atmosphere which will act as a blanket. This will result in the rise of atmospheric temperature all over the globe and may even cause melting of the polar ice-caps. The only way to prevent such a thing from happening is to arrest the denudation of forests wherever it is occurring and to afforest all bare and denuded areas of the earth at a rapid pace. Once there are enough trees on the earth the carbon dioxide problem would get solved.

Chapter III

NATURE'S THERMOSTAT

Forests have been an integral part of the earth's environment ever since this globe cooled down sufficiently to support life. Our planet is unique in being the only one known to science which can support life. There may be others in this vast Universe, but so far we do not know about them. We do know, however, that no other planet in our solar system possesses a life supporting environment. The moon may inspire poets with its beauty but in fact it is so desolate and forbidding and its environment so sterile that no life in any form is possible on it. The earth is immeasurably more beautiful as the astronauts who went to the moon realised.

What are the causes which make the earth so beautiful and so full of life? The main cause is the presence of life supporting oxygen in our atmosphere and the wonderfully controlled climate in which the temperature variation is confined to a maximum of about 100 degrees between minus 50°C and plus 50°C. If the maximum temperature of the atmosphere were to rise even by as little as 10°C to 20°C in any part of the earth, life forms as we know them would soon die of the intense heat. This delicate balance is maintained because of the layer of air which surrounds the earth and protects it from the fierce rays of the sun. If the protective layer of the atmosphere around the earth were not there, the sun's rays would cause the earth to heat up to thousands of degrees celsius. The atmospheric layer consists of gases like oxygen, nitrogen, carbon dioxide, carbon

monoxide, ozone and many others in minute quantities. In addition, it contains dust particles and water in the form of vapour. The last two are instrumental in moderating the heat of the sun's rays. The earth's atmosphere is about 300 kilometres deep. The air is the heaviest and the warmest next to the earth's surface and gets rarer and colder as we go up. Even as little as 20,000 feet above the earth's surface, the atmosphere is so rarefied and cold that it cannot support life without the aid of oxygen. Mountaineers who climb the high mountain peaks carry oxygen and wear specially insulated clothing not only to guard against the cold but also against the intense heat of the sun's rays.

Forests play a very vital role in helping the atmosphere to maintain the very narrow temperature range that exists on this earth. In order to appreciate this one must look at the water cycle. Two-thirds of the earth's surface is covered with water. Water evaporates due to the sun's rays and the vapour rises in the atmosphere. As it goes higher it gets cooled down into clouds. These cloud formations are carried by air currents over the land mass where due to interaction with mountain ranges and air currents generated by differential heating and cooling of the earth's surface as well as the rotation of the earth, the moisture in the clouds condenses and gets precipitated in the form of rain, hail or snow. This water or at least a major portion of it finds its way back to the sea through the rivers by surface flow. However, a sizable proportion of the water gets absorbed in the soil and is utilised by trees and other forms of plants for their growth as well as by human beings and animals. This water also goes back into the atmosphere through the process of evaporation and transpiration and falls back again on the earth in the form of rain, hail or snow. Thus the cycle is completed.

The role that forests and vegetation play in maintaining the water cycle is very important. First, they help the soil in absorbing a sizable proportion of the precipitation so that the entire quantity of water that falls on any area of the earth's surface, does not flow down rapidly only along the surface but also replenishes the sub-terranean aquifers from which it comes out

later either through natural springs or through wells and tube-wells. The moisture in the sub-soil is absorbed by the roots of trees and plants and after passing through the stem and branches of trees goes back into the atmosphere through the leaves. This causes a rise in the humidity of the surrounding atmosphere which results in moderation of the ambient temperature and reduction of aridity. The presence of moisture in the atmosphere results in an increase in the rainfall, particularly rainfall which is caused by local factors.

The water cycle described above is true if the earth is taken as a whole, but it does not hold good for all tracts on the earth's surface. There are large areas of the earth's surface which have no forest, and even though the water vapour from the sea passes over them, it does not get precipitated in the form of rain due to the almost total absence of forest and plant growth. The entire Arabian peninsula is an example where the monsoon which brings heavy rain to most parts of India, passes overhead without shedding a drop of rain except occasionally. If by some magic the Arabian peninsula could be covered with thick forests this would not happen and there would be regular and adequate rains which in turn would support thicker and heavier vegetal growth and thus set up a benign cycle. Actually what has happened in the past is just the opposite. Due to indiscriminate destruction of trees and grasslands in this region, there was a drop in the rainfall and an increase in temperature and dryness. This in turn resulted in further decimation of the vegetal cover. Thus the environment fell into a vicious cycle which resulted in permanent desertification.

As mentioned earlier, all the countries which were the cradles of ancient civilisation are now deserts. Let us examine the causes of this phenomenon.

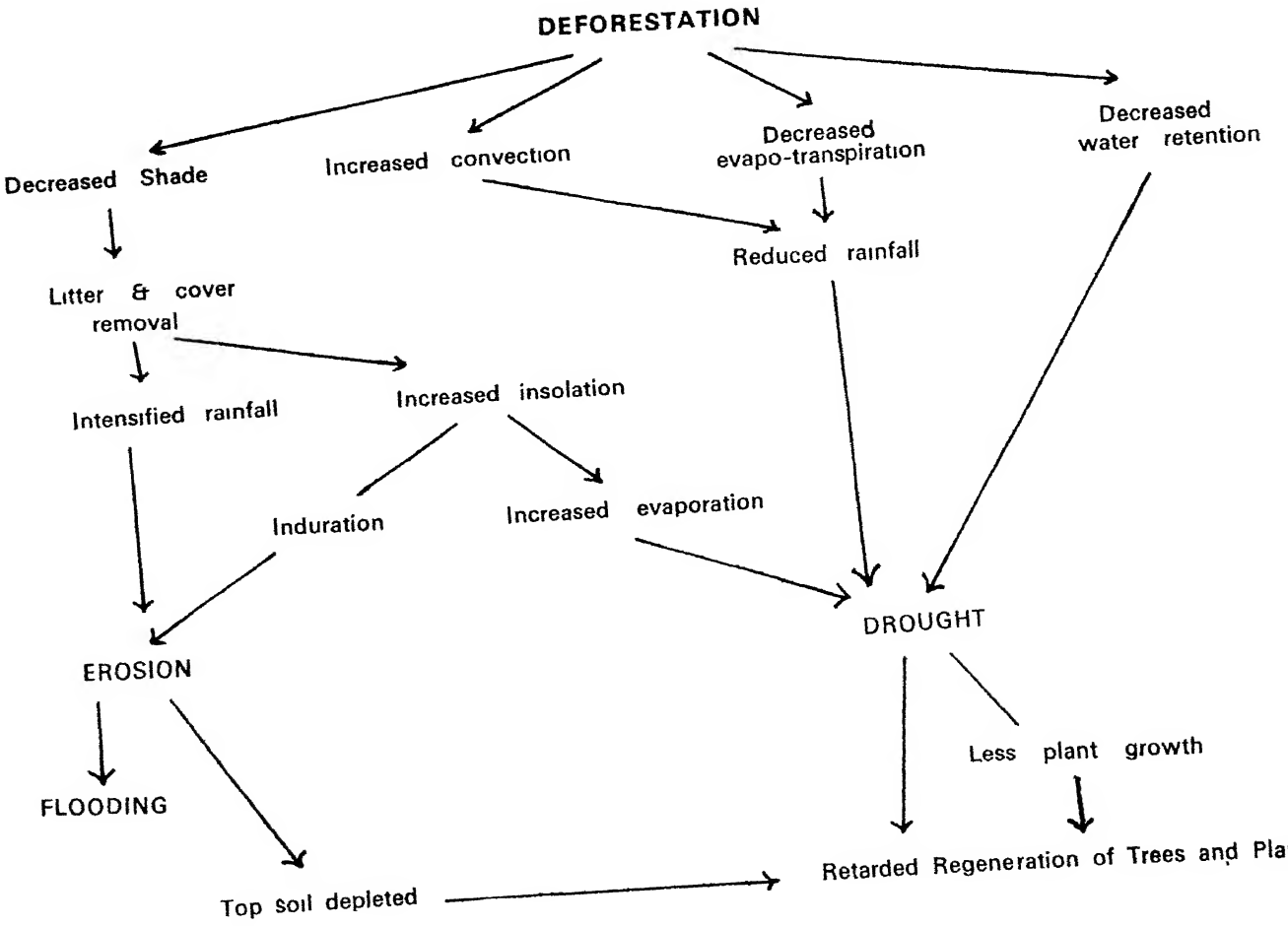
As civilisation advanced and man came out of the forest, he learnt to tame certain species of animals such as cows, goats, sheep, camels, horses and donkeys for food as well as for draught purposes. He turned more towards animal husbandry than hunting for his livelihood. He also learnt to domesticate

certain plant species, particularly those belonging to the grass family, which yielded cereal crops. Since both animal husbandry and agriculture require good soil and climate, the regions which possessed both in good measure attracted early man to colonise them. The regions of the earth which possessed, what is known as the Mediterranean type of climate, were found most congenial and thus the belt starting from Rajasthan in India through Sindh, Baluchistan, Afghanistan, Iran, Iraq, Arabia, Syria, Israel, Lebanon, Egypt, Tunisia and Libya to Morocco became the birth place of ancient civilisations which flourished many centuries back. With prosperity came peace and a more organised way of life. The people flourished and multiplied and so did their herds of cattle, sheep, goats and camels. There were plenty of forests from which to carve out agricultural fields. The forests were relentlessly destroyed for agriculture and those that were not, were over-run with grazing and browsing animals. Thus started a vicious cycle which ended many centuries later when all these lands became deserts.

The diagram on the next page clearly indicates environmental disruption caused by deforestation.

The quality of our environment depends not only on the maintenance of atmospheric temperature and humidity but also on all the living things, big and small, which Nature in her wisdom has created on this earth. Man is certainly at the apex of all Nature's creations but the pyramid of life on which he rests is large and its base very wide. From the most elementary form of life such as the amoeba and the protozoa, the environment contains uncounted forms of life in the shape of bacteria, fungi, plants, insects, birds, reptiles and animals. The Hindu belief that there are 84 lakh forms of life may not be accurate, but it is very nearly so.

All forms of life from the most microscopic to the largest tree or animal interact with each other and help to maintain the balance of Nature a truly delicate balance which if disturbed blindly can disrupt the quality of life on this earth and may, in due course of time result in the extinction of many life forms.


DEFORESTATION
Decreased Shade
Increased convection
Decreased evapo-transpiration
Decreased water retention
Litter & cover removal
Reduced rainfall
Intensified rainfall
Increased insolation
Induration
Increased evaporation
DROUGHT
EROSION
Less plant growth
FLOODING
Top soil depleted
Retarded Regeneration of Trees and Plants

Most people do not realise that even disease-carrying bacterial, fungi, poisonous plants and dangerous reptiles and animals have an important role to play in the nature of things. Disease-carrying bacteria and fungi attack and destroy plants and animals which are weak and without enough resistance, thus improving the genetic quality of the race. The dead plants and animals are further disintegrated by fungi and insects into nitrogen-rich soil which supports a richer plant growth and consequently a richer animal life. The basis of all animal life is grass and edible roots, leaves, flowers and fruits of plants. The herbivorous animals thrive on plants including grasses and the carnivorous animals prey on the herbivores. Insects eat leaves, flowers, fruits, seeds, wood and bark of plants and also eat other insects. They also eat nectar from flowers and in the process fertilise them. Birds eat seeds and fruits of plants, but in the fledgling stage almost all birds eat the larvae of insects which the parent birds collect and feed them. One pair of nesting birds will collect from 150 to 300 larvae a day during the five to six weeks that it takes for the fledglings to start foraging for themselves. Millions of insect larvae are thus consumed by birdlife and since most insects in the larval form cause damage to plantlife, including agricultural crops and forest trees, plantiful birdlife in any area constitutes the most effective and the cheapest form of pest control, far superior to man-made insecticides.

Birds in turn are eaten by other birds, reptiles and animals which keep their numbers within bounds. Animals prey on animals and thus keep the number of the herbivores under control. There is no waste in Nature. Even the remains of dead animals and birds eaten by other animals, birds or reptiles are consumed by birds such as the vulture, the kite and the crow and animals such as the hyaena, the jackal, the mongoose, the rats and many others. Thus one form of life subsists on another and keeps the population of different species under control and within the carrying capacity of the forest area.

Deforestation and indiscriminate removal of plant and

animal life upsets this balance with dire consequences to the environment. A self-regenerating and self-sustaining system is thus destroyed and a vicious cycle of environmental degradation comes into play. A recent occurrence of man interfering in the balance of Nature with disastrous results may be quoted from China.

Some agricultural scientists calculated the enormous quantities of foodgrains that were being eaten by sparrows and other small birds from the agricultural fields and came to the conclusion that if the sparrows and other grain-eating birds were destroyed the food production in the country would go up by so many million tonnes. Out came an order that all such birds should be destroyed, and all birds were destroyed in a short while. But the expected increase in the agricultural production did not materialise because with the absence of birds, the insect population multiplied so enormously that the damage to the crops far exceeded the comparatively small quantity of grains that the birds were eating and the cost of using insecticides proved far higher. The order had to be reversed and the birds were brought back and rehabilitated.

Similarly, snakes in India, contrary to popular belief, play a very beneficial role in the agricultural economy by keeping down the population of rats, mice and other rodents which damage enormous quantities of foodgrains. Not all snakes are poisonous. Only a few varieties like the cobra, the krait and the viper are poisonous but their contribution in maintaining a control over the rodent population far exceeds the loss that they cause to human and animal life.

However, this does not mean that no tree should be cut or that no animal, bird or reptile should be killed. They are all self-regenerating natural resources. If the removals do not exceed the rats of reproduction, they can be harvested safely without any harmful effects on the environment.

Chapter IV

FOSTER MOTHER OF AGRICULTURE

Forests play a very important role in supporting agriculture—a fact that is not very commonly realised by the people of the developing countries including our own. The common belief is that forests and agriculture are antagonistic land-uses not compatible with each other. This is based on racial memory dating back to pre-historic times when man cut down forests in order to obtain land for agriculture. In the olden days when the area of forests was much larger than the area that had been cleared for agriculture, the forests continued to play their beneficial role in maintaining the climatic balance and the water regime. But as the percentage of forests decreased in proportion to the increase in the area under agriculture, in many heavily populated regions of this and other countries, the ill-effects of deforestation became increasingly evident.

For successful agriculture the most important factors are good soil, a moderate climate, adequate water for irrigation, fertilisers and good quality seeds. Forests help to provide the first four. Let us examine how.

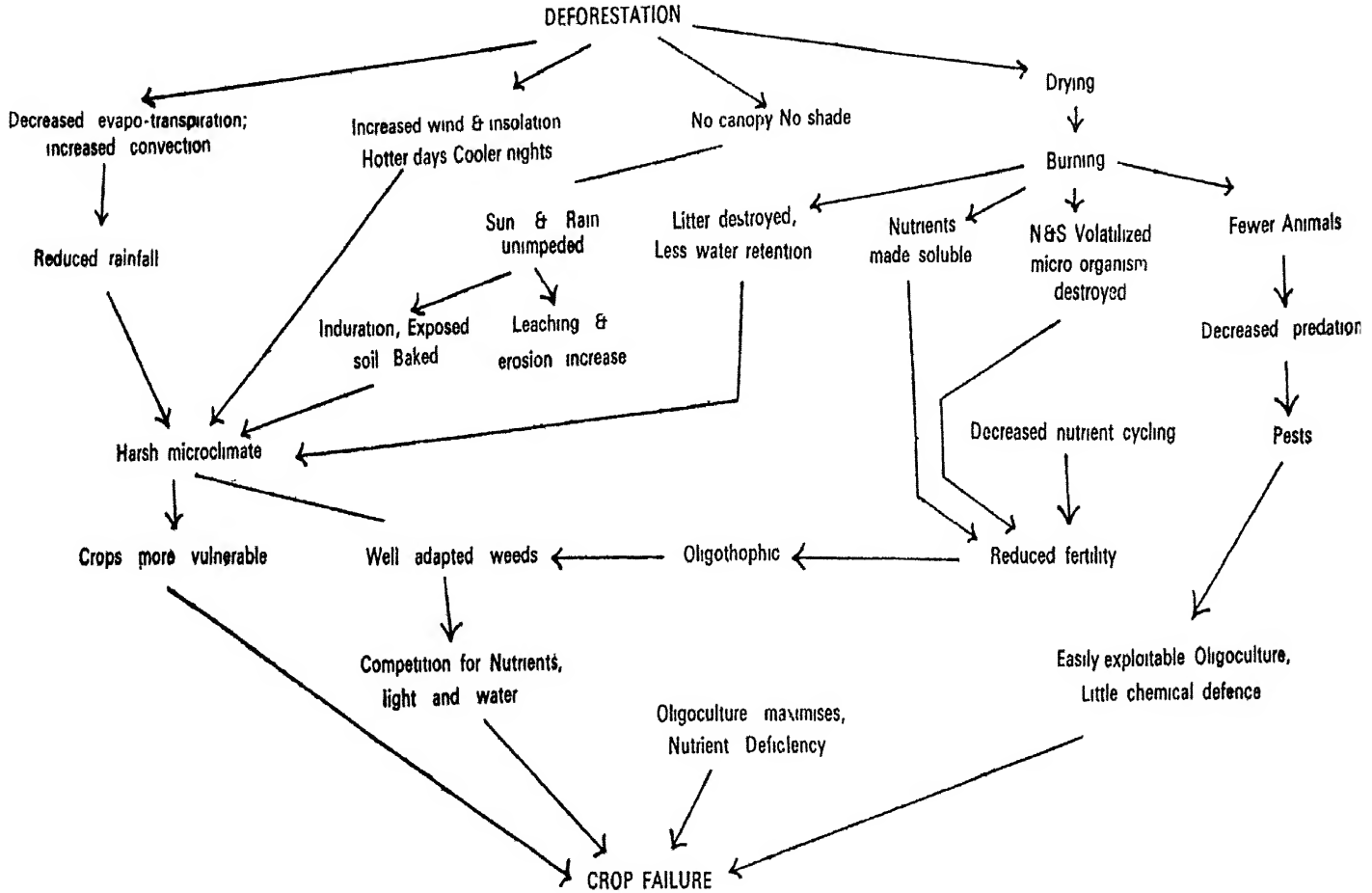
It has been made abundantly clear in the preceding chapter how forests play a moderating influence on the climate. The climate in any region is basically determined by its location on the globe, that is, its latitude, its nearness or otherwise to the sea and its altitude and topography. These are immutable and irrevocable factors pertaining to a particular region. But

what the presence of forests can do is to moderate the harshness of the local climate and protect the region from excessive cold and heat as well as excessive dryness.

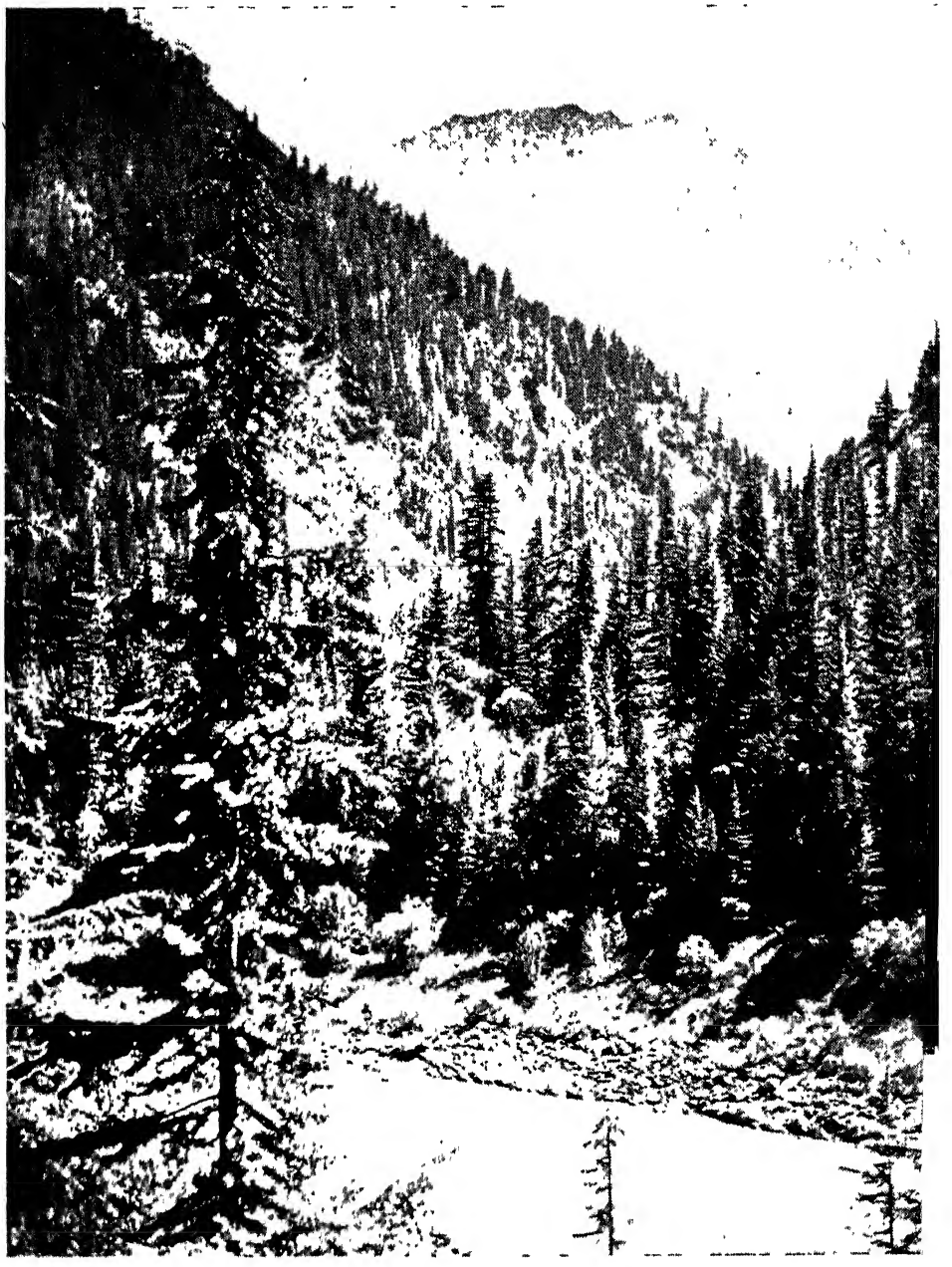
As far as the soil is concerned forests protect the rich top soil from erosion by wind and water and help to improve the quality of the soil. By helping to conserve the water that falls during the rainy season, by regulating flow in streams and rivers and increasing the storage of water below the surface of the ground, they help to provide a perennial source of water for surface as well as for sub-soil irrigation. At the same time they transpire large quantities of water into the atmosphere increasing the atmospheric humidity and moderating the ambient temperature. This results in a decrease in the need for irrigation. Forests also provide fertilisers from leaves and forest litter. By providing firewood they reduce the consumption of cowdung as fuel and thus indirectly increase the availability of fertilisers. It is not realised by many that the quantity of cowdung burnt every year in our country as fuel amounts to the equivalent of fertiliser produced by eight fertiliser factories of the size of Sindri.

Now, let us look at what happens in areas where forests have been removed. The earth becomes bare and has no protection from sun and rain. The soil gets baked by the sun and then gets eroded by water during the rainy season which results in the removal of the fertile top soil and heavy run-off rain water. This results in soil erosion on the one hand and siltation of waterways and river beds on the other, which reduces the water carrying capacity of rivers and streams. The heavy run-off during the rains combined with constriction of waterways results in rivers overflowing their banks and causing havoc. The moisture in the soil evaporates quickly. Decreased transpiration reduces atmospheric humidity and results in a reduction of the rainfall. All these factors create drought conditions.

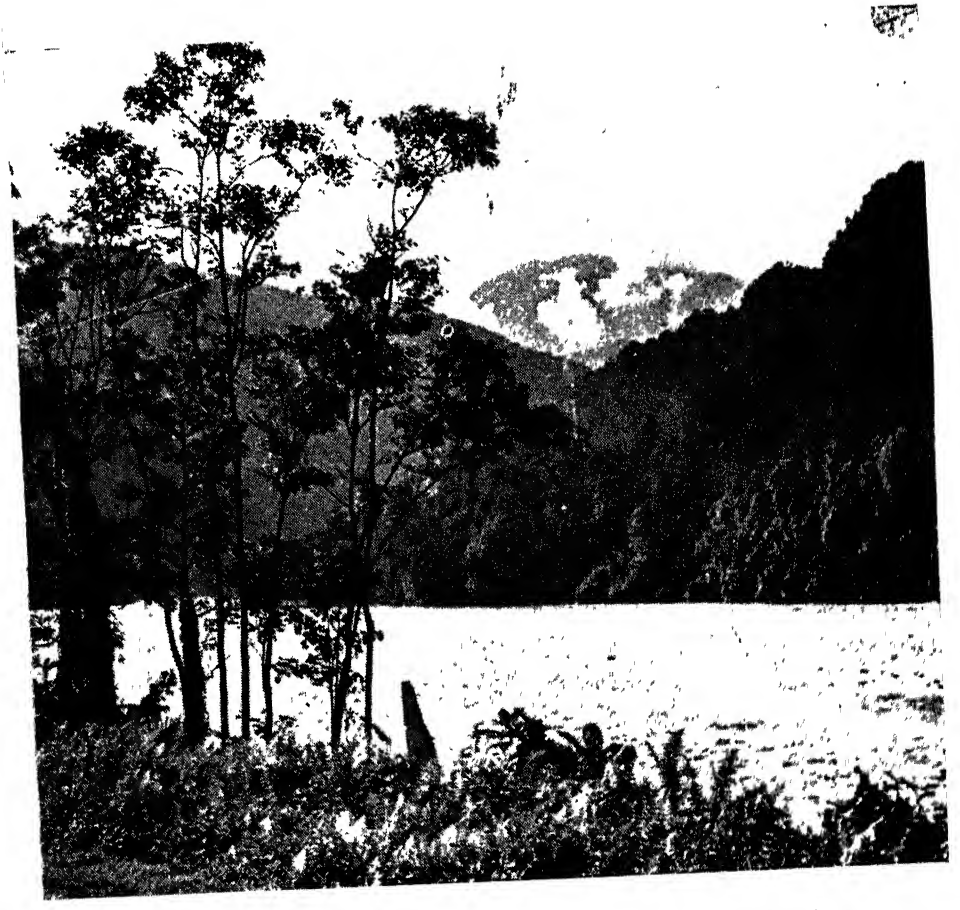
The relationship between deforestation and crop failure can be understood clearly from the following diagrammatic presentation.


DEFORESTATION
Decreased evapo-transpiration; increased convection
Increased wind & insolation Hotter days Cooler nights
No canopy No shade
Drying
Burning
Reduced rainfall
Sun & Rain unimpeded
Litter destroyed, Less water retention
Nutrients made soluble
N&S Volatilized micro organism destroyed
Fewer Animals
Induration, Exposed soil Baked
Leaching & erosion increase
Decreased predation
Harsh microclimate
Decreased nutrient cycling
Pests
Crops more vulnerable
Well adapted weeds
Oligothophic
Reduced fertility
Competition for Nutrients, light and water
Easily exploitable Oligoculture, Little chemical defence
Oligoculture maximises, Nutrient Deficiency
CROP FAILURE

Different Faces of the Forest

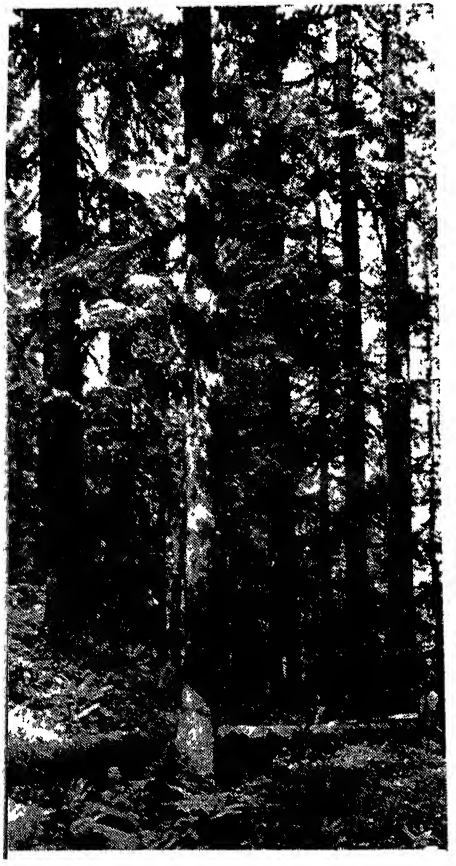


A valley in the high Himalayas.



A mighty river debouching into the plains Note the well-clothed hills.

A beautiful forest in Kerala



A magnificent sal tree.

A stand of deodars.

CAN FORESTRY AND AGRICULTURE BE PRACTISED TOGETHER

It is obvious that agricultural crops and tree crops cannot be grown on the same plot of land at the same time. Most agricultural crops cannot grow under the shade of trees except a few such as tapioca, ginger, turmeric or cardamom. It is a common belief that if you want to expand agriculture you must cut down forests. Partly it is true because as I said earlier, you cannot grow food crops under the shade of trees. But at the same time it is also very essential that forests must be maintained in the interest of agriculture itself.

So we must have forests if we want to have successful agriculture. At the same time if we have forests we cannot grow crops. What is the solution?

There are two ways of solving this problem. One, that the entire area on any tract should not be under agriculture crops alone. A certain percentage of land must be maintained under forests; particularly land which is sloping and is more liable to erosion. Land along natural waterways and streams and land which is not very fertile or which cannot give high yielding crops should be put under forests in order to moderate the local climate and maintain the temperature and water regime, so that the area does not become too dry in the summer season and the hot summer winds do not blow away the top soil. Therefore, we must have patches of forests interspersed with agriculture. Depending on the type of land, the soil and, above all, the slope of the land, it has to be decided how much land must be maintained under forests and how much under agriculture. If you were to go to Europe, you will find that both forestry and agriculture are practised together. There, you will see patches of forests interspersed with patches of agricultural land but you will not find large areas of land entirely under agriculture without any trees.

There is also the second possibility that trees can be grown inside a cultivator's field along the boundary of the fields in single

rows or even inside the field in single rows provided the lines are so laid that they do not cause excessive shading. There will be a certain amount of shading from the trees which will, perhaps, result in a small reduction in the crop yield but this will be offset by the fact that the presence of trees along the field boundaries would protect the fields from the dry desiccating winds and would thus conserve soil moisture and increase the productivity of the land.

The presence of trees in agricultural areas is also very important in our country where firewood is very difficult to get and the villagers have to rely on cowdung for fuel. You must have seen in the villages, little boys and girls roaming around collecting cowdung which is dried in the form of cowdung cakes and stacked for use as fuel. This is a very wasteful process because cowdung should really be used as farmyard manure and utilised for increasing the agricultural productivity. The villager knows about it but he cannot help because he has to cook his food and he has no other source of energy. Unlike people living in towns, he cannot rely on electricity or gas or even coal for cooking purposes and all that he has or the village housewife has is whatever agricultural waste that they can get in addition to all the cowdung that they collect and make into cowdung cakes. Now if the farmer were to grow sufficient trees in his own land, near his house, near his huts, along the road sides, near wells, near irrigation channels, etc., he could produce enough firewood for his domestic needs. And the entire quantity of cowdung produced by the cattle in the village areas would automatically be used as farmyard manure. A simple calculation shows that if an average Indian farmer, who converts the cowdung produced over 8 to 9 months of the year during the dry season as fuel, were in a position to use an alternative source for cooking and could use this cowdung for farmyard manure, his agricultural production would go up by at least 600 kilogrammes per annum on every hectare of land. It means that he is really wasting 600 kilogrammes of food as fuel.

It must be pointed out that the selection of trees that can

be grown along with the food crops on agricultural fields has to be made very carefully. One important quality of the tree should be that it should not be very shady. It should have a thin and narrow crown and it should be tall and straight so that it causes least damage to the agricultural crop. It should be comparatively fast growing so that it can produce wood in a short time say, five to six years. For this purpose there are many species amongst which the most useful is the eucalyptus. It is easy to grow and it grows fast. It produces quite a lot of wood in a short span of time. Above all, it has a narrow and thin crown, so the cultivator can grow it without causing damage to his crops. If an average farmer holding an area of about one hectare, that is 2½ acres, can raise 20 to 25 eucalyptus trees per annum in single rows for five years and thereafter from the sixth year start cutting 20 to 25 trees every year, he would become totally self-sufficient in his requirements for firewood. He would thus be able to utilise the cowdung from his animals for farmyard manure.

This will not only increase the productivity from his land but would also improve the micro-climate of the region. Imagine all the fields in the plains with a green garland of trees around them. How beautiful the countryside would look, and how nice and cool it would remain even in the hottest part of the year. If you happen to visit the valley of Kashmir you will see a very good example of agriculture and forestry being practised together. There, the villagers have learnt that growing poplar or willow along the edges of their fields in single rows gives them a sustained supply of firewood in addition to being a source of revenue from the wood which they sell to various factories for making packing cases, sports goods, baskets, etc. This technique of growing trees along with agricultural crops is called agro-forestry. In our country there is a great need for emphasising the introduction of agro-forestry on a very large scale.

Chapter V

BASE FOR INDUSTRY

As man became more and more civilised, his dependence on forests for raw materials for various needs increased. So much so that today there is no sphere of human existence where something or the other made from forest raw materials is not in use. Traditionally, timber has been the most important raw material for building purposes and before the advent of cement, roofs were laid on wooden beams and rafters. Even today, with reinforced cement concrete being widely used for structural purposes, the use of wood as a basic building material for houses has not lost its importance, particularly in the rural areas. In the western countries and in America cement concrete structures are confined only to the urban areas and most suburban houses and farm houses and barns are constructed with wood. Even in the use of cement concrete wood plays an important role for making shutterings, formers and templates. Other structural use of wood are in the making of bridges, culverts and even paving of roads. In Paris, there are many streets paved with wood which makes for a reduction in sound pollution.

Perhaps the most common and important use of wood is for making doors, windows and furniture. Since time immemorial wood has been the sole raw material for these purposes and even today with the introduction of steel and plastics as alternatives, wood continues to enjoy supremacy as the most sought after raw material for furniture, doors and windows.

Another very important use of wood is for railway sleepers.

Wooden sleepers were in use even before the invention of the steam engine for tram lines and in mines, using manual or animal power for pulling trams and trolleys. With the introduction of the steam engine and the expansion of the railway system all over the world the use of wooden sleepers increased enormously. In our country, the requirement of wooden sleepers by the railways is so large that it is becoming more and more difficult for our forests to satisfy it fully. Other materials such as steel, cast iron and reinforced cement concrete are being used to meet the shortage but experience all over the world has shown that these materials are not as good, in the interest of the life of the rolling stock and smoothness of travel, as wood.

Wood is essential for making matches, an important item of daily life. The estimated annual demand for matches is 14,000 million match boxes which require 4,85,000 cubic metres of wood or roughly 4,00,000 trees. The requirement of matches is estimated to go upto 38,590 million match boxes by the year 2000 A.D.

Till the end of the 19th century, wood was being used only in its natural form. Large sized beams hewn out of huge trees were used for structural purposes. Sailing ships were made out of wood and their masts and spars were made out of tall and straight trees. The dhows used by Arab sailors were, and are still, made from teak and other tropical timbers obtained from the forests of Kerala. All doors, windows and furniture were made of solid wood. But as the demand increased and the availability of wood became less and less, the technique of using composite wood instead of solid wood gained ground in Europe and America. In this process wooden logs are either peeled or sliced into thin veneers which are then pressed together using a resin adhesive to form what is commonly known as plywood. In this way one cubic metre of wood can produce a much larger area of wood surface than if it were used in the form of sawn planks.

There are many other forms of composite wood such as laminated wood, blockboards, compregnated wood, chipboard,

particleboard and fibreboard. Huge beams and trusses for supporting roof spans of 25 metres or more are fabricated by gluing and pressing together thin planks of small size which can be obtained from smaller trees. Compregnated wood is another interesting product which is made by using a large number of thin veneers and pressing them with certain kinds of resin under high temperature and pressure to produce a very hard and high density material which can be heavier than steel and just as strong. Compregnated wood is used for making special components which cannot be made of steel or other metals either because they have to be electrically non-conducting or because they have to work in water.

The panel industry which includes the manufacture of ply wood, block board, chipboard, particleboards and fibreboards is very advanced in the western countries. In our country also this industry is expanding rapidly. At present, the total installed capacity is: plywood - 43 million sq. mts., chipboard - 45,000 tonnes, fibreboard 40,000 tonnes. The total requirement of timber for this purpose is of the order of 3,90,000 cubic metres.

In the field of sport, wood plays an important part. Cricket bats and stumps, hockey sticks, tennis, badminton and table tennis rackets, billiard tables and cues are all manufactured from special quality woods and cane, all of which comes from the forests. Rubber which has so many multifarious uses is also manufactured from the latex of a forest tree.

But perhaps the most important contribution of the forests to the present day civilisation is providing the raw material for making paper. The Chinese who invented paper several thousand years back used the inner bark of certain trees for making paper. Today paper is made mostly from wood, bamboo and certain types of grasses. The paper on which this book has been printed must have been made out of wood or bamboo. No work can be done today without the use of paper, and it would not be an exaggeration to say that paper is the very foundation of our present day civilisation.

There are a large number of other raw materials which come from the forests. Pine trees yield resin from which resin and turpentine are manufactured. Resin is used in the sizing of paper and textiles and for making paints, varnishes, polishes and adhesives. Turpentine is used for making paints and varnishes. It is also used for medicinal purposes and now is being used for the manufacture of artificial camphor which is used for medical purposes and religious ceremonials. Natural camphor is also a forest produce and comes from the wood and leaves of the camphor wood tree which is mostly found in China and Taiwan. But now in our country all camphor is obtained from turpentine. Certain forest trees yield gums which are not only used for sticking paper but are also used in the manufacture of sweets and ice-creams.

Medicinal herbs and plants are another important gift from the forests to mankind. They are in great demand both in the Ayurvedic and Unani as well as the modern systems of medicine. The Ayurvedic and the Unani systems of medicine have been practised in our country for centuries and they both rely on medicinal plants and herbs. In every village shop in India one can buy dried roots, bark, leaves, flowers or fruits of various medicinal plants which are used for common ailments. Even the Western pharmacopoeia is increasingly turning towards medicines based on phytochemicals.

In the life of our rural people forest produce play a vital role by providing them hutting and thatching material, wood for making bullock carts, agricultural implements and household furniture and fibres for making ropes, nets, mats, baskets and a host of other items of daily use.

With the rapid industrial and economic development of the country the demand for forest raw materials has increased tremendously. The major industrial consumers in the organised sector are paper, plywood, matches, paints and varnishes. In the non-organised sector the major consumers are saw-milling, packing cases, building and structures, cabinet making, pencil making and sports goods. The chemical,

pharmaceutical and cosmetic industries are also becoming increasingly large consumers of phytochemicals. Among the cottage industries almost all need some forest produce or the other. To name a few, wood carving, ivory carving (ivory is also a forest raw material), basket weaving, mat making, toy making, indigenous medicines and manufacture of matches (70 per cent of the total production of matches in India comes from the cottage industries sector), all depend on the forests for their raw materials.

Chapter VI

A MANY SPLENDOURED THING

Forests with their beautiful trees, creepers, bushes and grasslands provide a cool, pleasant and peaceful haven for people living in towns and cities surrounded by the monotony of daily life and living in a jungle of brick and concrete. The bigger and more advanced the town the farther life in it is from Nature. There is hardly any greenery to be seen except in parks and along roadside avenues. Then there are the constant noise and roar of motor cars and trucks and the air polluted with poisonous fumes emitted by motor vehicles and factories. Children born and brought up in big towns such as Bombay or Calcutta hardly ever see the soil of the earth. For them and for grown-ups as well, a holiday in the forest, where the air is pure, the weather pleasant and the scenery beautiful, can be a wonderful and invigorating experience. It refreshes both the body and the mind.

Forests harbour a large variety of animals, birds and reptiles. To see them in their natural surroundings is a thrilling and rewarding experience. A tiger in its natural habitat looks far grander than in a zoo or in a circus. Herds of deer browsing peacefully in a forest glade are a feast for the eyes. Then there is the peace and quiet of the forest broken occasionally by the singing of birds, the alarm call of deer when they sense danger, the trumpeting of wild elephants and the sawing call of a panther or the roar of a tiger. The sounds of the jungle are many and varied and the thrill that they give is to be experienced to be believed.

Our country is very rich in the variety of fauna that its forests contain. Elephants, rhinoceros, wild buffaloes, bison, tiger, panther, snow-leopard, brown bear, Himalayan black bear, the sloth bear, sambhar, swamp deer, cheetal, hog deer, barking deer, nilgai, black buck, chinkara, wild pig, hyaena, wild dogs jackals, wild cats and hares are some of the more important wild animals found in our forests. This is by no means a complete list and the variety of animals, birds and reptiles is as wide as it is unique. No other country in the world can boast of a heritage as rich as ours.

The basis of all wildlife is grass. The herbivorous animals live on grass which is their staple food. Among these animals are elephants, rhinoceros, wild buffaloes, bison, deer, antelope, gazelles and wild pigs which live entirely on grass and leaves in the forest. The carnivorous animals such as tiger and panther, the wild dog, the hyaena and jackal and various types of the smaller wild cats live on the flesh of herbivorous animals. In an undisturbed forest there is a natural balance between the prey and predator populations. But this balance can only be maintained if the home and food of wild animals are not destroyed or unduly disturbed by human beings.

The forest is full of natural beauty and presents beautiful and varied scenery. Tall stately trees, vast rolling grasslands, trees and climbers with beautiful flowers or leaves; patches of bamboo looking like giant ferns; rivers, streams and lakes full of crystal clear water, where all the wild animals come to drink and nature in the raw in all its moods are the priceless gift of the forest to mankind.

Hunting and fishing is another important form of recreation which a well-managed and well-protected forest provides. Wildlife is a self-generating natural resource and like any other similar resource can provide a sustained harvest if care is taken to see that animals and birds are not shot or netted indiscriminately and excessively without control. Unfortunately in the last 30 years, two things have happened which have seriously decimated our wildlife. First, the area of the forest has

been seriously depleted and in many of the remaining forests there is excessive human interference; and secondly, the game laws which were framed to ensure that no animals or birds are killed during the breeding season and the females and young are protected to ensure adequate reproduction, have been followed in their breach. Poaching from motor vehicles at night has become common and has reduced a noble sport into senseless slaughter.

Like all sports, hunting has to be done according to rules and since there is no referee present to ensure the observance of these rules, the entire responsibility of observing them devolves on the sportsman himself. The forests and wildlife staff are there to keep a check but it is the sportsman, who in the final analysis, has to maintain strict self-control on his trigger finger to ensure that this valuable resource lives on for ever and is not exterminated. Commercialisation of hunting by the large number of shikar companies which sprang up after Independence and catered to a dollar-rich clientele, were largely responsible for the destruction of our tiger population.

But the most serious and heavy damage to our wildlife has been and continues to be from the local poacher, from villages adjoining the forest and organised gangs operating from big towns for commercial benefit from the sale of meat, skins and horns. Rigid surveillance and strict observance of game rules can provide wonderful sport for a large number of people on a sustained basis without any depletion of our fauna.

In order to preserve our wildlife in perpetuity a number of National Parks and Game Sanctuaries have been established. The difference between a national park and a game sanctuary is that while a national park is established through an Act of Parliament or a State Legislature, sanctuaries are established through an administrative order of Government. National parks are permanent and their boundaries cannot be changed whereas sanctuaries are established for a stated period of time which may or may not be extended and the boundaries can also be altered or modified. In India we have 45 national parks. The most

famous among them being the Kanha National Park in Madhya Pradesh. the Corbett National Park and Dudwa National Park in Uttar Pradesh. In these national parks human activity and interference is reduced to a minimum and the wildlife gets an opportunity to exist and multiply in a natural manner without any interference or danger from man. In the game sanctuaries which number 210 at present, similar protection is afforded to all forms of wildlife except that in some cases controlled forest exploitation is permitted. The most famous game sanctuary in India is the Gir Lion Sanctuary in Gujarat, where the Asiatic lion, which once roamed freely all over the north western India, Pakistan, Iran, Iraq and Arabia and has now become extinct, still survives. This is the only part of the earth where the Asiatic lion still exists due to strict protection accorded to it for the last 80 years or more.

All our national parks and sanctuaries are a source of unsurpassed pleasure and recreation to tens of thousands of visitors each year as they afford a rare opportunity for people to see the rich fauna of our country in its natural habitat.

Chapter VII

THE FLORA OF OUR FORESTS

AREA UNDER FORESTS AND GROWING STOCK

India has a total forest area of about 75 million hectares (see Appendix I for a statewise break up) constituting about 23 per cent of the land area. As against this, agriculture occupies about 158 million hectares which comes to 48.5 per cent of the land area. The ratio of forests area falls far short of the minimum of 33 per cent (60 per cent in the hills and 20 per cent in the plains) stipulated by the National Forest Policy of 1952. Moreover, the forests are unevenly distributed. For instance, the thickly populated North Indian plain consists mainly of agricultural land, the forest area being hardly 7.5 per cent of the land area. In the Deccan about 18 per cent of the land area is under forests as against 60 per cent under agriculture. In the western and eastern Himalayan region, however, forests constitute about 50-60 per cent of the land area while in the Andaman and Nicobar Islands, it is as high as 95 per cent. The percentage of forests to land area in some countries of the world including India is given below :

World average	30
Australia	4
U.K.	6
Mexico	24

India	23
U.S.A.	31
USSR	39
Canada	45
Burma	62
Japan	70

About 60 million hectares of our forest area are under legally constituted "reserved" and "protected" forests and are under organised management. The remaining area consisting of unclassed forests is generally not under systematic management.

About 65 million hectares (86.7 per cent of the forest area) are classified as productive forests, while the forest area under actual exploitation is about 58 million hectares. The remaining 10 million hectares (13.3 per cent of the forest area) are managed as protection forests and preserved for regulation of stream flow, prevention of floods and soil erosion, stabilisation of shifting sands, protection of catchment areas, etc. The areas under the main timber species viz. teak, sal and conifers are about 9, 10 and 4 million hectares respectively. With two per cent of the world's forest area and 15 per cent of the world's population, the per capita forest area in India works out to 0.15 hectare as against the world average of 1.19 hectares. About 95.3 per cent of our forests is State-owned, 2.9 per cent belongs to panchayat and only 1.8 per cent is under private ownership. India's total wood production is hardly one per cent of the total world production indicating that productivity per hectare in India's forests is far below the world average.

Out of the total forest area of about 75 million hectares, about 71 million hectares (i.e. about 95 per cent) are under forests of broad-leaved species and only about four million hectares (i.e. nearly five per cent) under coniferous forests. The broad-leaved forests comprise nearly 10 million hectare of sal forests situated in Uttar Pradesh., Bihar, Madhya Pradesh, Orissa, West Bengal, Assam and Tripura; about 8.5 million hectares of teak forests situated in Gujarat, Maharashtra, Madhya

Pradesh Andhra Pradesh, Karnataka, Tamil Nadu and Kerala and about 52.6 million hectares of miscellaneous forests. The coniferous forests occur over an area of about 4 million hectares, mainly in the States of Jammu and Kashmir, Himachal Pradesh and Uttar Pradesh in the western Himalayas and to a lesser extent in Assam, Arunachal Pradesh, West Bengal and Manipur in the north-eastern region.

The total volume of growing stock in the country comes to 1733 million cubic metres. Adding another 40 per cent to this figure to account for the younger age classes which were not enumerated, the total estimated growing stock in our forests has been assessed at 2400 million cubic metres, comprising about 86 per cent hardwoods and 14 per cent softwoods. Assuming an average value of Rs. 100 per cubic metre, the total estimated value of this growing stock comes to Rs. 24,000 crores, apart from the value of land.

FOREST TYPES

It would not be an exaggeration to say that no country in the world possesses such a wide variety of forest types as India. The reason for this is not only the vast size of our country which stretches from south to north between 7° north and 37° north latitudes and from west to east from 68° to 98° longitudes, but also a wide variation of topography. There are countries in the world which have a hot and humid climate, there are others with hot and dry climates and there are those which enjoy temperate and cold to extremely cold climates, but there is no other single country which can boast of possessing all these climatic variations.

The existence of the Himalayas imparts a rather unique characteristic to our climate. Running from east to west they protect the north Indian plains from the cold arctic winds during the winter, thus giving them a warmer climate during the winter months than they would have otherwise had. They also act as a stopping wall for the south west monsoon and cause

heavy precipitation, with the result that the north eastern region of India is perhaps the wettest in the world. Moreover, due to the protection afforded by the Himalayas, a set of climatic conditions are created which result in the existence of a tropical climate even at latitudes several degrees north of the Tropic of Cancer. On the other hand the existence of such high mountain ranges creates cold conditions at various altitudes in the Himalayas. Temperate, cold temperate, alpine and even arctic conditions can be encountered depending on the altitude, even though the latitude may be only 30° to 35° north.

Consequently, our vast sub-continent with its wide range of climate and topography exhibits a great diversity of natural vegetation, characterised by forest types ranging from tropical wet evergreen to arid deserts and from alpine meadows to littoral forests and tidal swamps. Few countries in the world can surpass India in the wealth and variety of her luxuriant flora which includes over 4000 woody species and provides a wide choice of timbers suitable for different purposes.

Forest types may be classified on the basis of vegetation, the various climatic zones in which particular classes of vegetation are expected to flourish, or the properties of the mature ecosystem comprising the vegetation-environment complex reflecting the interrelations of these elements. This subject has been exhaustively dealt with by Champion and Seth* who have classified the forests of India into the following broad groups.

(a) MOIST TROPICAL FORESTS

GROUP I. Tropical wet evergreen forests
(annual rainfall about 2500 mm)

Tall, dense forests with mesophytic evergreens predominating in all canopy layers. On the main land, this type is found in

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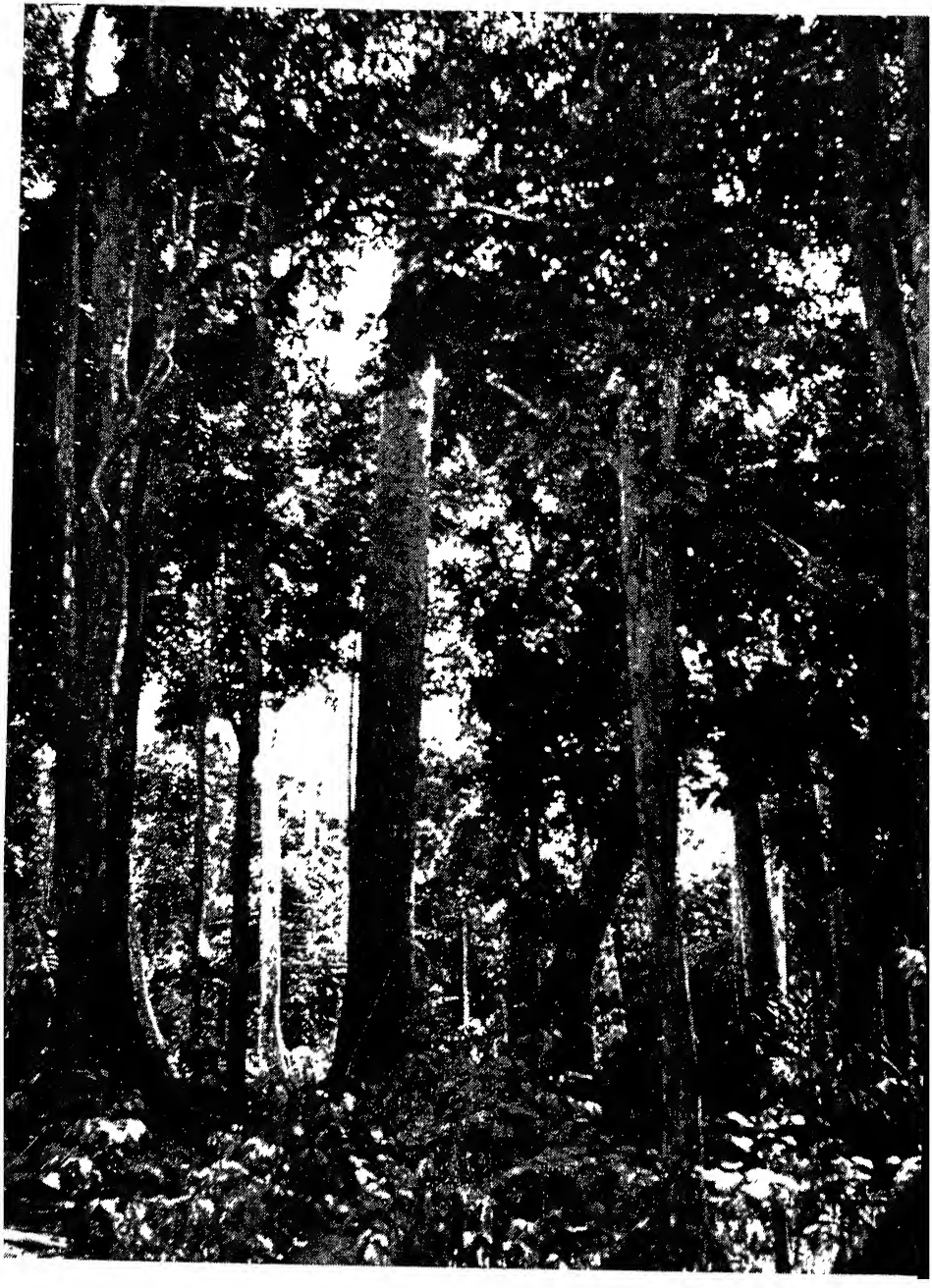
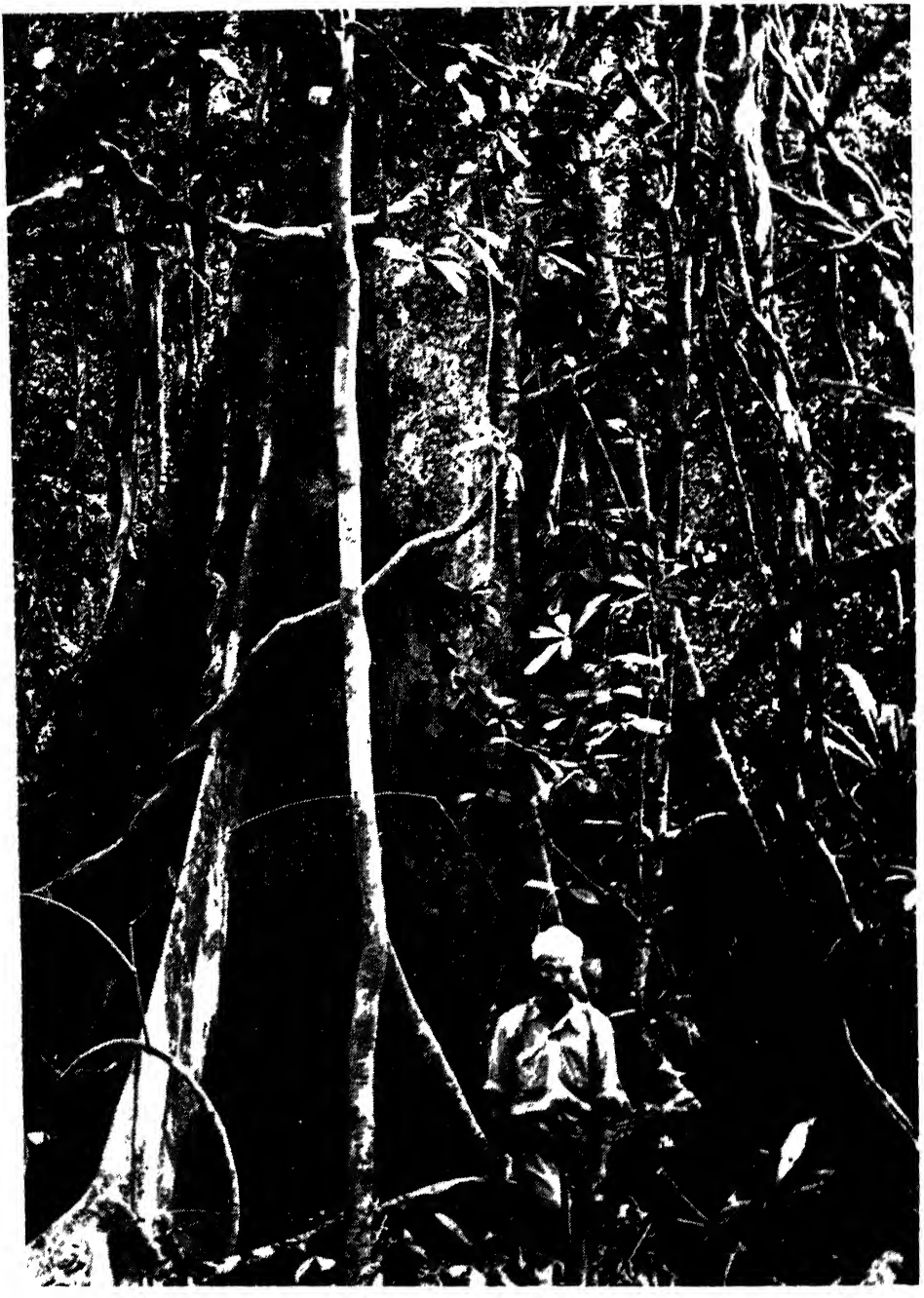
* *A Revised Survey of the Forest Types of India,* Champion and Seth, 1968

Types of Forest



Moist tropical wet evergreen forest.

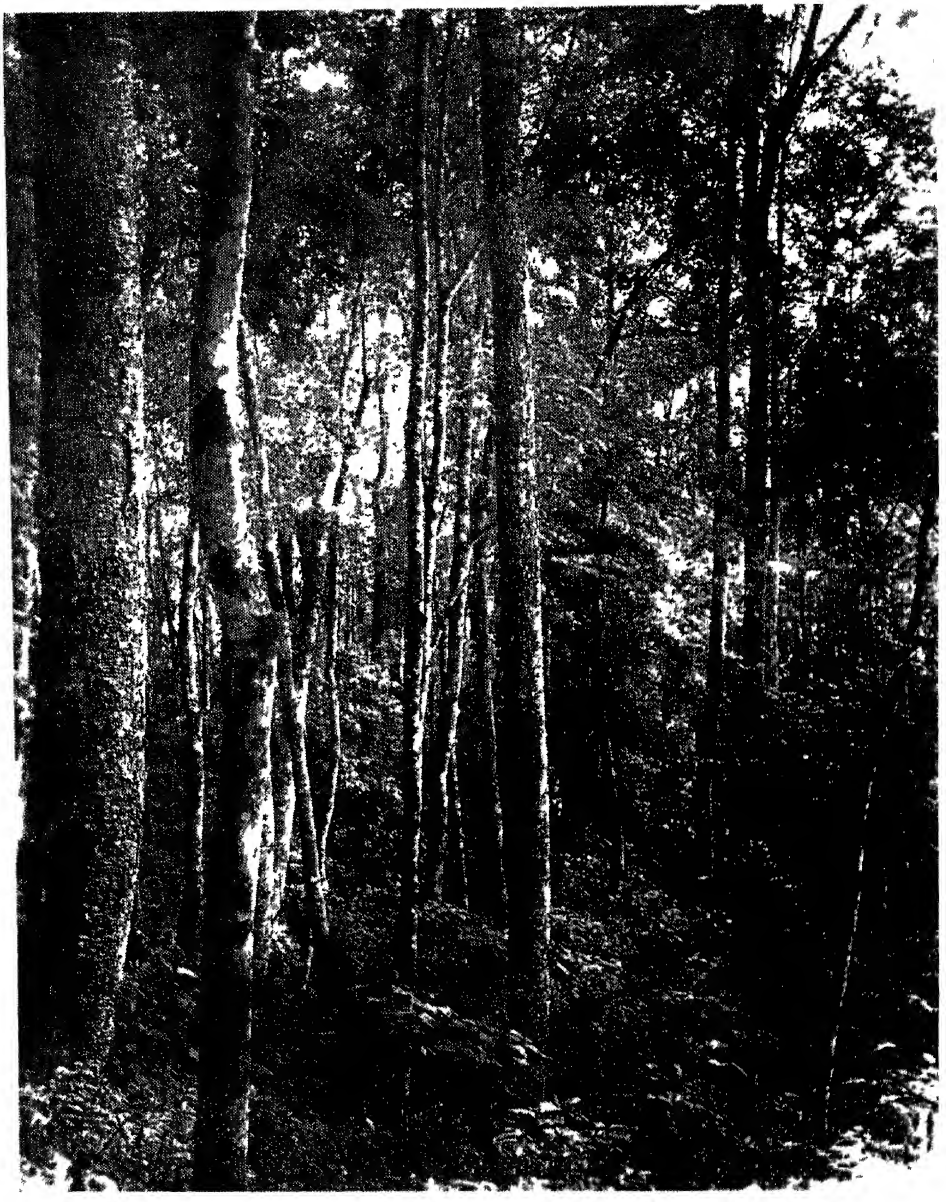


Moist tropical semi-evergreen forest—note the size of the tree and the heavy buttressing which Nature provides to give stability to such tall trees.

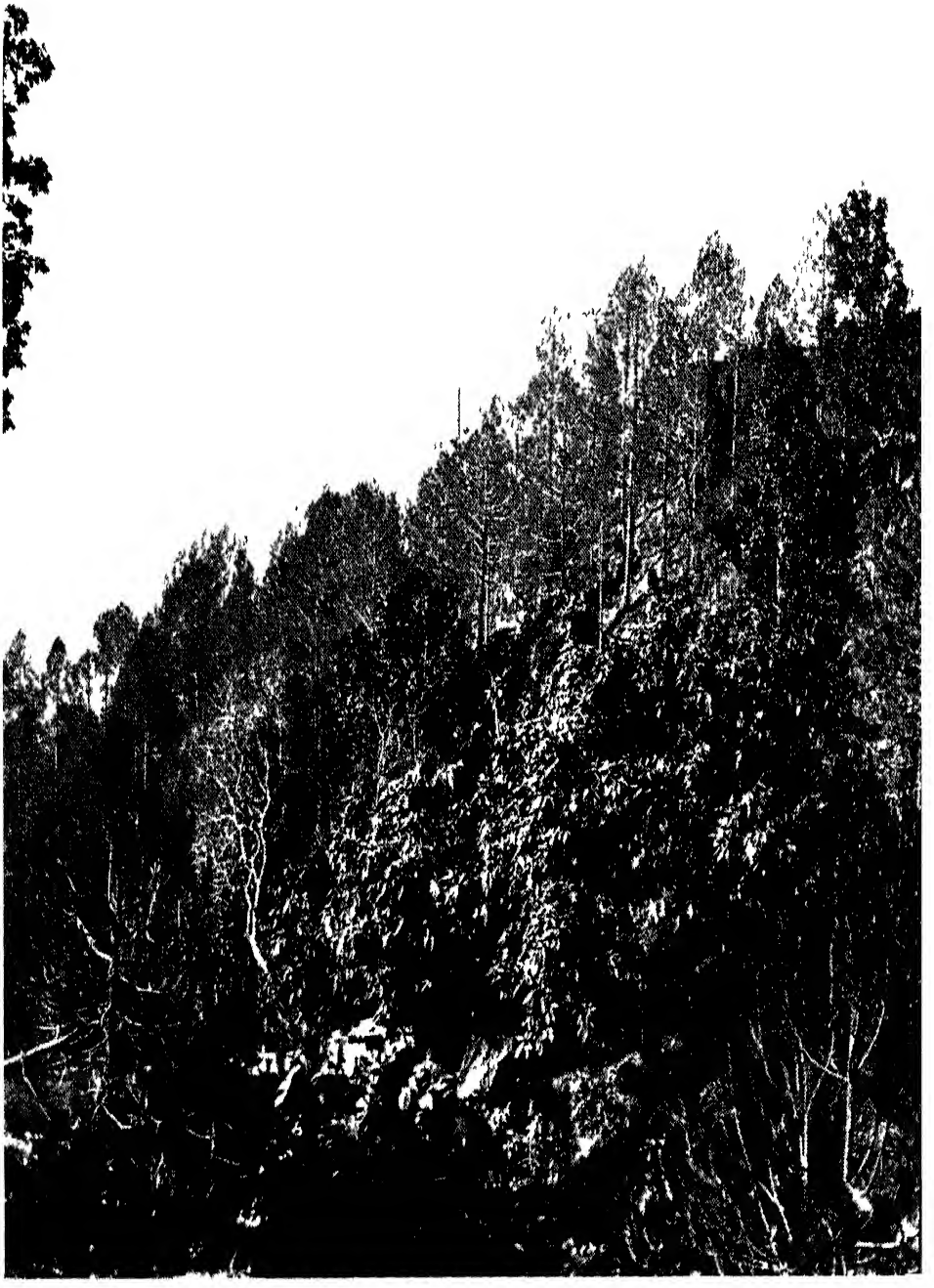
Tropical moist deciduous forest

Dry tropical thorn forest—babul tree in the foreground.

Dry tropical evergreen forest



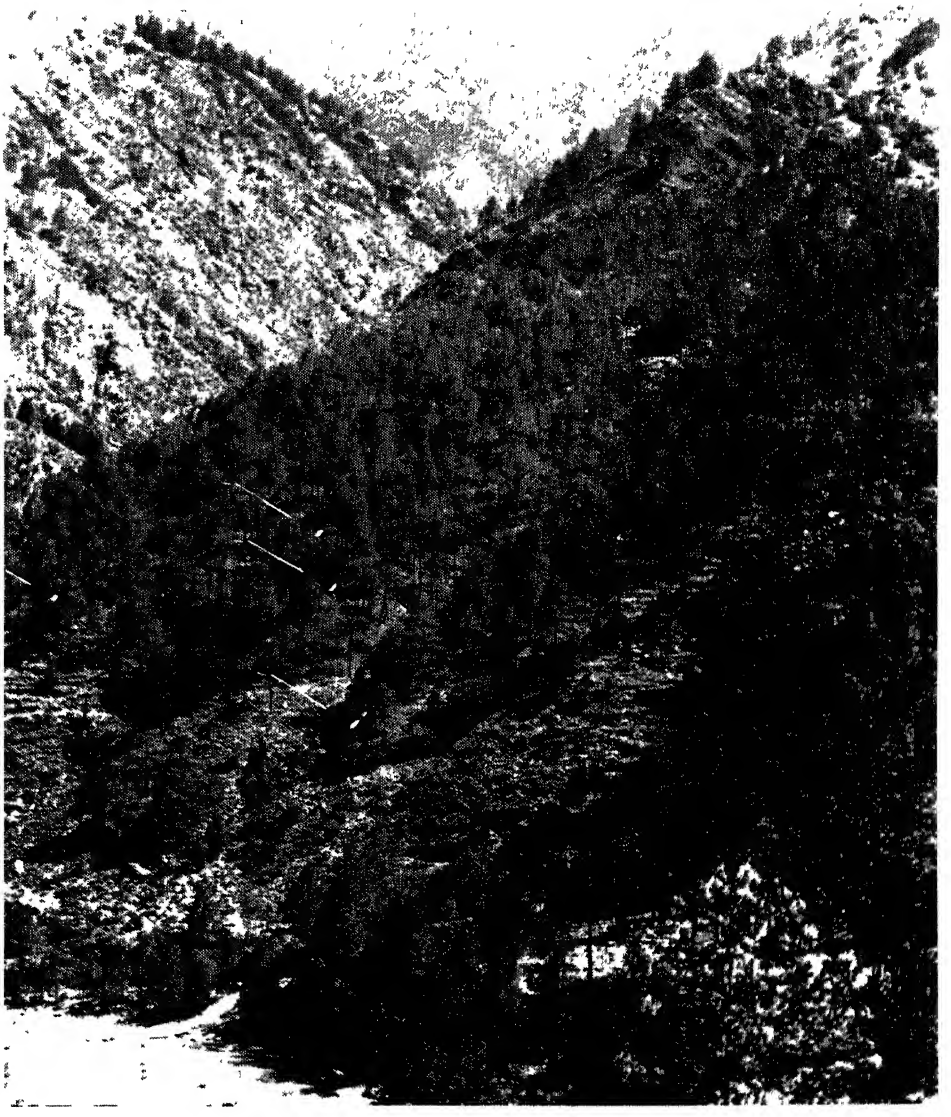
Montane subtropical broadleaved forest



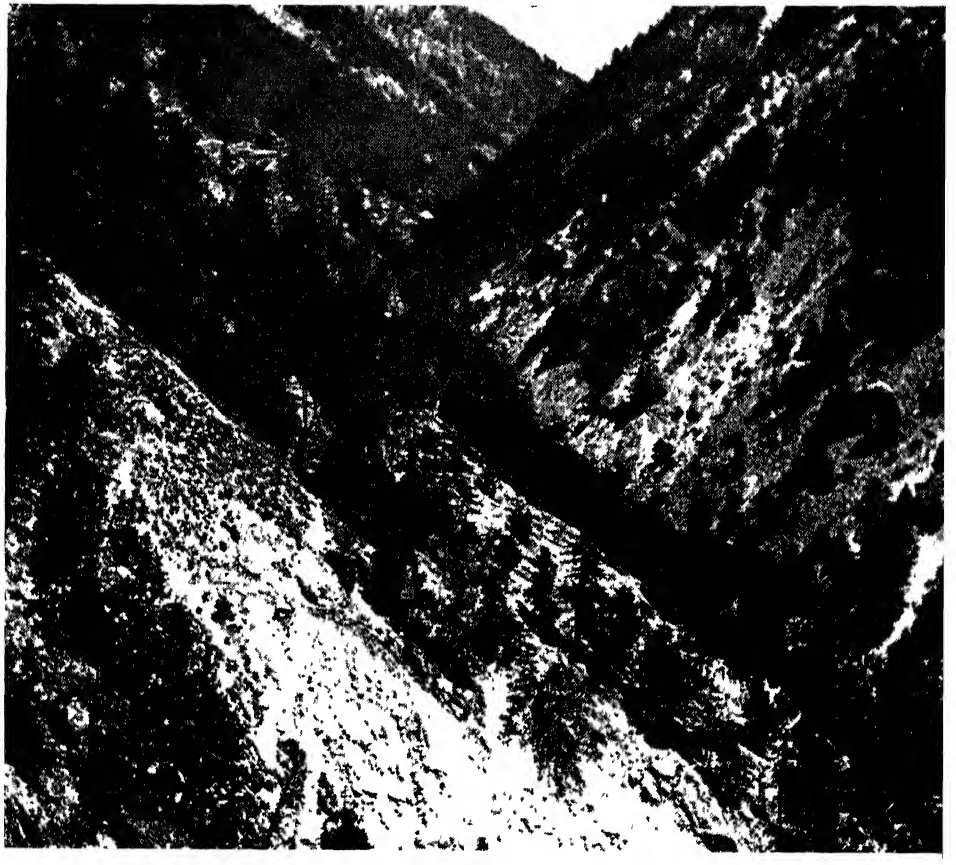
Montane subtropical pine forest

Subtropical evergreen forest

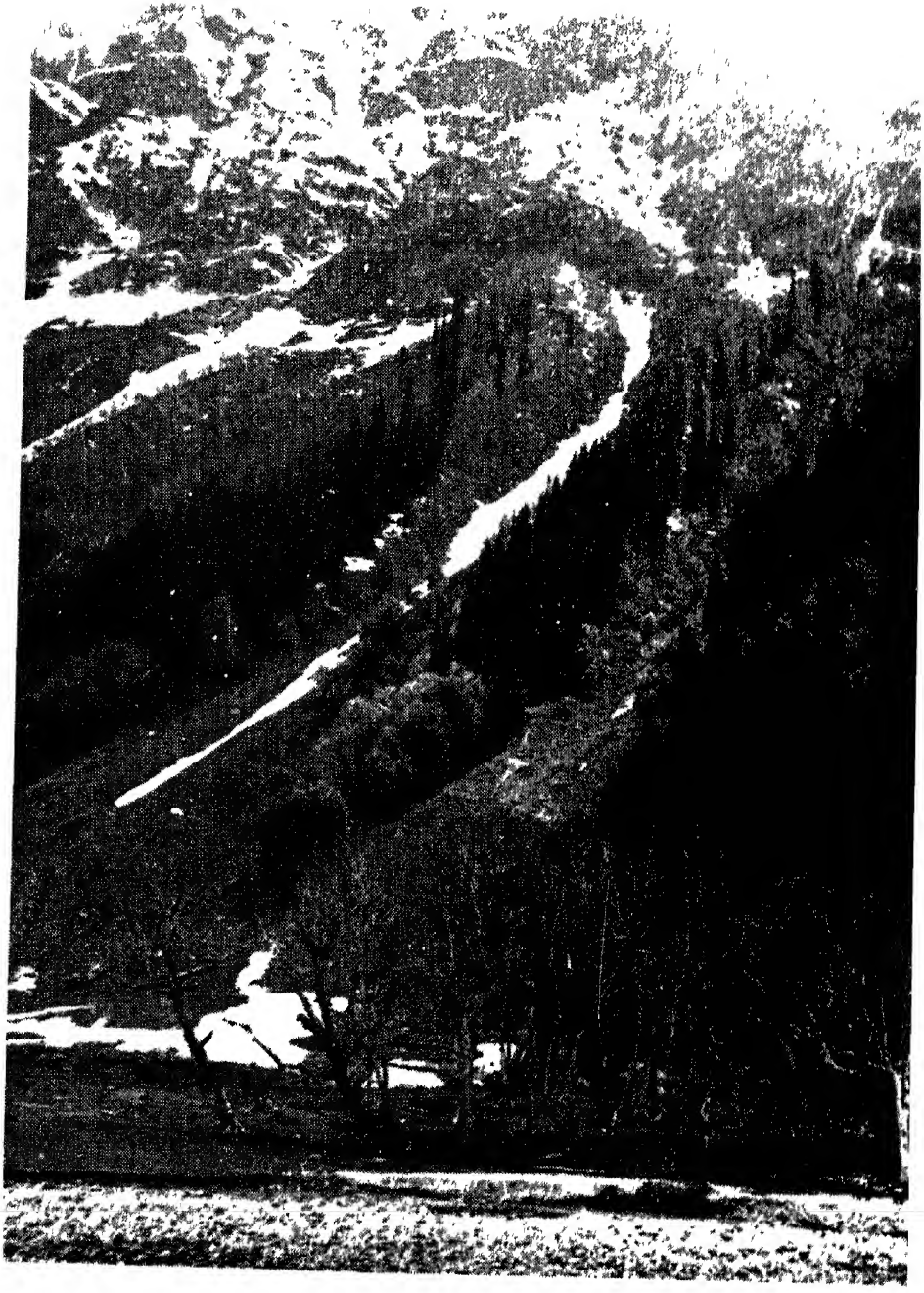
Montane wet temperate forest



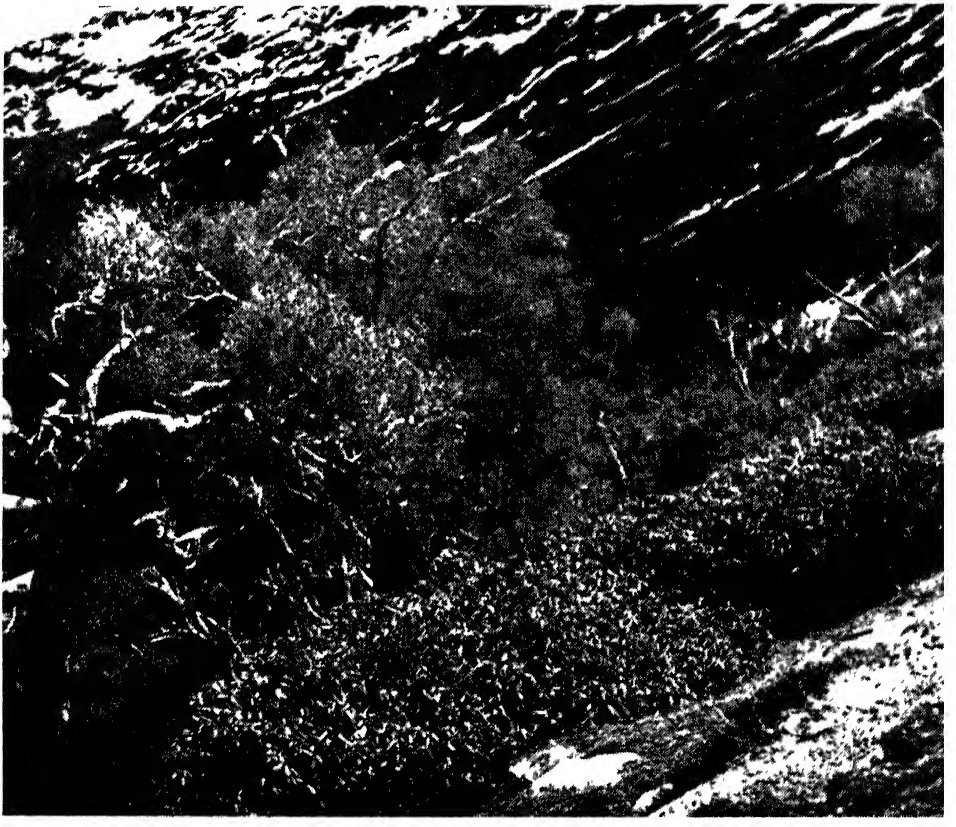
Himalayan moist temperate forest.



Himalayan dry temperate forest—stunted fir and spruce trees and juniper bushes



Sub-Alpine forest—birch (Bhojpatra) in the foreground
and fir on the slopes in the background.



Moist alpine scrub—juniper bushes

Alpine scrub—stunted juniper bushes.

regions with rainfall over 2500 mm. along the western face of the Western Ghats and in a strip extending south-west from upper Assam through Cachar. These forests are the main source of plywood timber. The characteristic genus is Dipterocarpus (gurjun, padauk, hollong, etc.) the other important species being Balaquim ellipticum, Cullinia excelsa, Mesua ferrea (nahor), Measura assamica, Shorea assamica (makai), etc.

GROUP II. Tropical semi-evergreen forests
(annual rainfall 2000 to 2500 mm)

Deciduous species occur mixed with the evergreens in the top canopy, the lower canopies being mainly evergreen. Leafless period is short. This type usually adjoins the tropical wet evergreen, forming a transition from the moist deciduous. It is found locally along the Western Ghats, and occupies considerable areas in Assam and the lower slopes of the eastern Himalayas. The main species are Dipterocarpus, Terminalia (Indian laurel) Bombax (semul), Hopea, Schima Wallichii, Bauhinias (kachnar) Artocarpus (jack-fruit), Mangifera (mango) and Michelia, (champa) the last three being of local occurrence in Orissa.

GROUP III. Tropical moist deciduous forests
(annual rainfall 1500 to 2000 mm)

Deciduous species predominate in the top canopy which is rarely dense and even, with more or less evergreen species in the lower canopy. It occurs as a strip along the foot of the Himalayas and another strip along the east side of the Western Ghats, a large block centering on Chhota Nagpur and a tract to the lee of the Khasi hills. Most teak of good quality is characteristic of the southern forests, while sal forms the greater proportion of the northern half of the range including the valuable sal forests of Uttar Pradesh, Bihar, Orissa and Madhya

Pradesh. Other associated timber species are padauk, rosewood, laurel, siris, benteak, etc. with bamboos in the understorey. In both the regions, small or large stretches of forest without teak or sal also occur. In the eastern plains, Terminalia myriocarpa (hollock), occurs and Bombax, Albizia (siris) species etc. on the alluvial savanna.

GROUP IV. Littoral and swamp forests
(annual rainfall 760 to 5000 mm)

Mainly evergreen species of varying density and height but always associated predominantly with wetness. These forests occur throughout India wherever local conditions are suitable for their development. The littoral and tidal types occur all along the coasts, especially on deltas of larger rivers on the east coast. The seasonal swamp forests are more characteristic of north-eastern India. Casuarina equisetifolia, Calophyllum, Inophyllum and Manilkara littoralia are typical beach forest species. Tidal mangrove vegetation includes chiefly Rhizophora, Bruguiera, Ceripos and Heritiera which are good fuel species. Barringtonia, Syzygium cumini (jamun), Dillenia (chalta), Cephalanthus, etc., occur in seasonal swamps whereas species like Myristica, Bischofia, Trewia (gutel), Diosphyros, Terminalia arjuna (arjun) and Legerstroemia (jarul) species are characteristic species along the fringes of water courses.

(b) DRY TROPICAL FORESTS

GROUP V. Tropical deciduous forests
(annual rainfall 1000 to 1300 mm)

Low forests with a light top canopy, almost entirely deciduous in all canopies. This type occurs in an irregular wide strip from north to south of the country, from the foot of the Himalayas to Cape Comorin, bounded on the north-west by the Rajasthan desert, on the south-west by the Western Ghats, and on the east

by the wet forests of Bengal. Dry teak and dry sal are characteristic species in the north and south respectively with an abundant understorey of bamboo (Dendrocalamus strictus). Both these species are absent over extensive areas towards the drier end of the group. From place to place, edaphic variations have resulted in pure associations of Anogeissus pendula (dhau), Boswellia serrata, Hardwickia binata, Acacia nilotica, (babul), Butea monosperma (dhak), Aegle marmelos (bel), Phoenix (khajur) species with red sanders (Pterocarpus santalinus) over a restricted area of Andhra Pradesh forming a separate type by itself. In Karnataka, Tamil Nadu and Andhra Pradesh this type contains valuable forests of sandalwood (Santalum album).

GROUP VI. Tropical thorn-forests
(annual rainfall 460 to 940 mm)

Low, open, predominantly xerophytic forests in which thorny legumes predominate. This type occupies a big strip in the Indus basin in Haryana, southern Punjab and Rajasthan where the rainfall is about 250 to 750 mm., and is also found over large areas in the upper Gangetic plain, the Deccan Plateau and lower peninsular India. This type is of little value from the point of view of timber production. The main characteristic species of North India are Prosopis cinirarea (kairi), Acacia nilotica, A. Catechu (khair), A. Leucophloea and Zizyphus (ber) species. In the south A. Catechu, degraded to Euphorbia scrub through the severe play of biotic influences.

GROUP VII. Tropical evergreen forests
(annual rainfall 850 to 1250 mm)

Low often dense forests, of hard-leaved evergreen trees in which thorny small leaved species predominate. It is restricted to a relatively small area on the Karnatic coast which receives very little summer rain. It is of no importance for the production of

commercial wood. Memecylon edule, Maba buxifera etc., are the characteristic species.

(c) MONTANE SUB-TROPICAL FORESTS

GROUP VIII. Subtropical broad-leaved hill forests
(annual rainfall 1500 to 6500 mm)

These constitute luxuriant forests with evergreen species predominating. This type is limited to the lower slopes of the eastern Himalayas in Bengal and Assam and of local occurrence over other hill ranges such as the Khasi, Nilgiris and Mahabaleswar hills. In the south form, Lauracea species are generally present. The northern form contains Quercus (Oak) and Castanopsis, with Schima as a typical associate.

GROUP IX. Sub-tropical pine forests
(annual rainfall 1050 to 3000 mm)

Open pine forests sometimes with and often without an evergreen underwood. This type includes the pure chir pine forests found between 1000 m. and 1875 m. elevation through out the central and western Himalayas, and local occurrence of Khasi pine in the Khasi hills at corresponding elevations. Pinus roxburghii (chir pine) is the only pine in the western Himalayan region and Pinus kesiya in the Khasi hills. Oaks and rhododendrons are the main associates.

GROUP X. Sub-tropical evergreen forests
(annual rainfall rarely exceeds 1000 mm)

Xerophytic forests including thorny and small-leaved evergreen species. This type is found only in the north western corner of the country and is of no significance for timber production. The typical species are Olea cuspidata (olive), Acacia modesta and Dodonaea.

(d) MONTANE TEMPERATE FORESTS

GROUP XI. Montane wet temperate forests
(annual rainfall 1500 to 6250 mm)

Evergreen or semi-evergreen mixed broad-leaved forests with dense undergrowth. The forests are characteristic of the eastern Himalayas, between 1800 m. and 2900 m. elevation and also occur on the tops of hills of South India. In the southern forms, typically developed in the Nilgiris, both tropical and temperate floral elements are represented, Syzygium and Ternstroemiacea species are of importance and Rhododendron nilgiricum is as conspicuous as Rhododendron arboreum in the Himalayas. In the northern forests, oaks, chestnuts and Laureaceae species are abundant and rhododendrons come down from the alpine forests above. The chief genera are Machilus, Quercus and Castanopsis. This type is a source of several light timbers of good decorative quality and some veneer timbers.

GROUP XII. Himalayan moist temperate forests
(annual rainfall 475 mm to 2500 mm)

Evergreen forests of conifers or oaks or a mixture of both. Undergrowth rarely dense and partly deciduous. These are found between 1500 m and 3000 m elevation in the central and western Himalayas, especially in the north-west, except where the rainfall falls below 1000 mm in the inner ranges. The occurrence of oaks or coniferous forests depends on minor local variations.

The western Himalayan forests may be divided into a lower and an upper zone, in each of which different oaks and/or conifers dominate. In the lower zone, among oaks are Quercus incana (banj oak) and Q. Himalayana and among the conifers Cedrus deodara (deodar) with Pinus wallichiana (kail or blue pine), Picea smithiana (shruce) and Abies pindrow (fir) are the

most predominant in order of increasing altitude. In the upper zone, Q. Semecarpifolia (kharsu oak) and Abies pindrow are dominant. There may be some pockets of deciduous broad-leaved vegetation, mainly edaphically conditioned, in both the zones. The eastern Himalayan forests include Tsuga dumosa with Quercus lineata and Quercus lamellosa in the lower one and Tsuga dumosa, Picea spinulosa and Abies densa with Quercus pachyphylla in the upper zone. Cypress is the chief adaphic variant, Cupressus torulosa being dominant on limestone and some other dry formations. Alders colonise new gravels and sometimes blue pine does the same. These forests are an important source of coniferous timbers, though extraction is often difficult.

GROUP XIII. Himalayan dry temperate forests
(annual rainfall 80 to 800 mm)

Evergreen forests with open scrub undergrowth. Both coniferous and broad-leaved species are represented. These occur on the inner ranges of the Himalayas throughout their length and are best represented in the north-west. In the western forms, dry zone deodar, Pinus gerardiana (chilgoza) and /or Quercus and Ilex are the chief species. Higher up, the blue pine communities and in the drier inner reaches, Juniperus macropoda forests also occur. The eastern form contains Abies, Picea, Tsuga, etc. Locally Larix griffithiana occur on moraine soils at 3000 to 4000 m elevation.

(e) SUB-ALPINE FORESTS

GROUP XIV. Sub-Alpine forests
(annual rainfall 80 to 650 mm)

Evergreen conifers and mainly evergreen broad-leaved trees occurring in a low open formation. This type occurs throughout the Himalayas above 3000 m elevation adjoining Alpine

scrub and is mostly situated on inaccessible terrain. In the west, Abies spectabalis and Betula utilis are typical, while Avies densa and Betula utilis are found in the east with rhododendrons as the chief understorey.

(f) MOIST ALPINE SCRUB

GROUP XV.

Low scrub of evergreen conifers and mainly evergreen broad-leaved species, patchy and localised, often only upto 1 m. high. This type occurs above the timber line upto 5500 m. Rhodo-dendrons, with some birch in the west are the main species, juniper communities are also common, Juniperus wallichiana, J. communis and J. recurva being the main species.

(g) ALPINE SCRUB

GROUP XVI.

Dry alpine scrub. Very often xerophytic formation in which dwarf shrubs predominate. This type is found at the upper-most limit of vegetation and is widespread in the inner ranges behind the main Himalayan axis, with rainfall always below 380 mm. The chief genera are Juniperus, Carangaura and Eurotia and Salix, Myricaria and Hippophae rhamnoides along the streams.

Chapter VIII

AND THE FAUNA

The natural fauna in any country depends on the floral types found in it. As has been pointed out in the previous chapter, India has a large variety of flora. This combined with the widely different climates found in our country has resulted in the existence of a wide variety of birds, animals and reptiles. As far as variety goes, no other country including Africa, is as rich as India. It is true that some countries in Africa are very rich in wildlife but they contain certain types of wildlife peculiar to the savannah type of forests, belonging to the antelope and gazelle families and predators which prey on them such as the lion, the leopard and the cheetah. It is also true that in these African countries the numbers in which the wildlife occurs is sometimes enormous, and herds running into tens of thousands are not uncommon. In India, wild animals may not be found in such enormous numbers but the variety is as large as it is fascinating.

It would be presumptuous to attempt to describe or even to enumerate all the species of wild animals, birds and reptiles that are found in this country in the limited space of this chapter. A brief bird's eye view of the more important and well-known species is being given.

The animal kingdom can be roughly divided into two main groups — the flesh eating or carnivores and the grass eating or herbivores. Among the carnivores we have the Asiatic lion, the Indian tiger (also sometimes known as the Royal Bengal

Tiger), the panther or leopard, the snow leopard, the fishing cat, the wild cat, the caracal, which all belong to the cat family. Those belonging to the dog family are the grey wolf and the Tibetan black wolf, hyaena, the wild dog, the jackal and the fox. Among the smaller carnivores are the ratel, the marten, the civet cat and the mongoose.

Among the herbivora, the largest is the wild elephant followed by the rhinoceros, the wild buffalo and the bison. India has several species of deer, three species of antelope and two species of gazelles, all of which are mistakenly classed as deer. In the deer family, the largest in size is the sambhar followed closely by the hangul or the Kashmir stag. The swamp deer, known as the barasinga or the gond, is also a large deer but somewhat smaller than the sambhar. The next in size and perhaps the most beautiful is the axis deer or the cheetal which is only slightly less beautiful than the almost extinct thamin or the brown-antlered deer. The hog deer or para, barking deer and the four horned deer are small, but the smallest member of the deer family found in our country is the mouse deer or chevrotain which is hardly larger than a hare.

Unlike Africa which has many varieties of antelopes and gazelles, India has got only three varieties of antelopes, the nilgai or the blue bull and the black buck found in the plains and the Tibetan antelope found on the high Himalayan plateaux and two varieties of gazelles, the chinkara and the Tibetan gazelle.

We have three kinds of bears. The brown bear which occurs in the Himalayas at high altitudes, the Himalayan black bear which occurs at lower altitude and the Indian sloth bear which is found in the plains. Among the cat-bears are the binturong and the panda. In the Himalayas are found two varieties of wild sheep, the ibex, the markhor, the wild goat or tahr, the serow and the gural.

We have two varieties of pig, the Indian wild pig and the pigmy hog, the former widely spread all over the plains forests and even in the Himalayas upto 9000 feet altitude, and the latter

rather rare in the north-eastern region. There are no rabbits indigenous to India, the domesticated variety is an exotic, but there are several varieties of hare which occur, the common Indian hare being very widely spread whereas the larger marsh hare is very rare. We have no hedgehogs, but the porcupine is common both in the forests and the agricultural areas. We also have one variety of ant-eaters, the pangolin, which is common in the sal forest but, being very shy and nocturnal in habit, is not easily seen.

The largest reptile is the fish-eating crocodile or the gharial which was once very common in our larger rivers but has now become almost extinct. The other two varieties of crocodile found in India are the snub-nosed crocodile or mugger and the salt water crocodile which is similar to look at as the mugger but is found only in the coastal waters along India's eastern coast and in the Andaman Islands. Contrary to common belief there are no alligators in India, the snub-nosed varieties of crocodile being sometimes mistakenly called alligator.

The largest snake found in India is the python which is nonpoisonous but nonetheless dangerous because it kills by coiling itself round its victim and crushing it to death before swallowing it entire. Among the poisonous snakes the most dangerous is the king cobra, which is highly poisonous and has been known to attack unprovoked, the common cobra, the Krait, the Russell's viper, the saw-scaled viper and the pit viper. A large variety of nonpoisonous snakes are found in India. Among them the most common is the rat-snake, or dhaman. The fresh water snake is also nonpoisonous but the sea snakes are all highly poisonous.

India does not have any of the larger apes such as the gorilla, the orang-utan and the chimpanzee, but we have several members of the monkey family such as the black-faced baboon or the langur, the common red-faced macaque or the rhesus monkey, the lion-tailed macaque the crab-eating macaque and the golden langur.

The largest bird is the sarus crane which stands almost 1.5 metres high and the smallest is the little sun-bird hardly

7cm long, which flits from flower to flower sucking nectar like the butterfly. We have several species of storks such as the adjutant stork, the open-billed stork and the spoon-bill. We also have several varieties of herons and aigrets. Among the geese and ducks that come to India during winter are the Persian grey lag and the barheaded goose, the Brahmini duck, the comb duck, the mallard, the pochard, the shoveller, the spot bill, the pin-tail, the merganzer, the teal and the coot, four varieties of snipe, the jack, the fantail, the pintail and the painted. Other waders are several species of sand pipers, pippits, moorhens, jacanas and stilts. Plovers, curlews and ibises are also found.

The partridge family is well represented. We have the snow partridge above the snow line in the Himalayas, the chukor and the hill partridge at lower altitude and the swamp partridge, black partridge, painted partridge and the grey partridge in the plains. We have also several species of quail.

In the Himalayan region there are different varieties of pheasants. Near the snow line are found snow pheasant and at the extreme limit of the timber line the beautiful monal pheasants, the blood pheasants and the tragopan. Lower down are found the koklas, the cheer (getting almost extinct) and the kalij. The peafowl is found all over the Indian plains and the red jungle fowl in the sal forest areas and its southerly cousin the grey jungle fowl throughout peninsular India. In the central Indian region the spur fowl is also found.

The above list of animals, reptiles and birds found in India is descriptive, but by no means exhaustive, and only gives an idea of the wonderful variety of our fauna. To give the distribution of the species mentioned above we may divide India into the following regions :

1. The Himalayan region;
2. The North Indian forests in the foot-hills and the plains;
3. The North-Eastern region;
4. The Deccan plateau;

5. The Southern region;
6. The Coastal region; and
7. The Desert region

1. THE HIMALAYAN REGION

Starting from the highest altitude, the wildlife found are the Tibetan black wolf, the nyan or the giant wild sheep, the kyang or the Tibetan wild ass, the Tibetan gazelle and the Tibetan antelope, the Himalayan blue sheep or bhurral, the ibex, the markhor, the tahr, the gural, the musk deer, the serow, the hangul, the sambhar, the barking deer, the brown bear and the Himalayan black bear. Among the carnivora are found the snow leopard and the common panther and occasionally the tiger. In the eastern Himalayas the tiger has been found even upto altitudes of 10,000 ft. preying on domestic yaks in the summer months.

2. THE NORTH INDIAN FORESTS IN THE FOOT-HILLS AND THE PLAINS

Wild elephants are found in the forests of Uttar Pradesh, Bihar and Orissa. In the foot-hills are found the tiger, the panther, the sloth bear, the Himalayan black bear, the sambhar, the swamp deer, the cheetal, the hog deer, the barking deer, the wild pig, the porcupine, the common hare and the marsh hare, the ratel and the pangolin, the hyaena, the wild dog, the jackal and the fox. Among the reptiles both the gharial and the mugger are found in the north Indian waters, the python, the king cobra, the common cobra, the krait, the vipers and the rat snake. Among the game birds, the peacock, the kalij pheasants, the red jungle fowl, the spur fowl, the swamp partridge, the black partridge, the painted partridge, grey partridge and the quails.

3. NORTH-EASTERN REGION

The wildlife found in this region includes the wild elephants, the rhinoceros, the wild buffalo, the bison (called the

Mithun), the tiger, the panther, all kinds of deer found in the northern region as well as the brown-antlered deer or the thamin, which is almost extinct but is still found in small numbers in the State of Manipur. The pigmy hog is also found in this region in addition to the wild pig but is rare. In the eastern Himalayas the wildlife is much the same as the western Himalayas except for the fact that no wild sheep or goats are found and there are certain species of cat-bears such as the binturang and the panda, which are peculiar to this region. Another species only found in the north eastern region is the golden langur.

4. THE DECCAN PLATEAU

The fauna of this region is similar to the fauna found in the plains of north India except that there are no wild elephants and rhinoceros. Both bison and wild buffaloes are found. The red jungle fowl gets gradually replaced by the grey jungle fowl as we go further south. Amongst the deer-like animals all the members of the deer family (except the Kashmir stag), the nilgai, the black buck and the chinkara are found.

5. THE SOUTHERN REGION

The fauna of southern region is very similar to the plains forest of the north-eastern region. Being a tropical region there is a larger variety in the types of birds and snakes found. The tiny mouse deer and the lion-tailed macaque are peculiar to this region. There are no wild sheep or goats except the Nilgiri thar which is found on the higher altitude in the Nilgiris.

In the Andaman and Nicobar Island there are no tigers or panthers nor wild elephants. The only species of deer found is the cheetal which was introduced from the Mainland and is not indigenous. A peculiar inhabitant of this island is the megopod, a partridge like bird with large feet. Another peculiarity is the coconut crab which climbs up coconut trees and eats the fruit. The crab-eating macaque is found here.

6. THE COASTAL REGION

The coastal region including the Andaman and Nicobar Islands is inhabited by the salt water crocodile. Around the Chilka Lake in Orissa black bucks occur whereas in the Sunderban in West Bengal cheetals are found. So are tigers which, for reasons yet undiscovered, tend to become man-eaters more easily than tigers elsewhere in India.

7. THE DESERT REGION

The desert region which comprises parts of Punjab and Haryana, Rajasthan and Gujarat is characterised by animals and birds which prefer wide open spaces and arid scrub forests to thickly wooded and greener forests. Consequently, antelopes and gazelles are common. The Asiatic lion, which once used to be common all over West Asia, is now found only in a small pocket in Saurashtra in Gujarat. Another species peculiar to Saurashtra is the onager or the Indian wild ass. Amongst the birds, the great Indian bustard, the lesser bustard and the sandgrouse are peculiar to this region. Amongst the rodents the gerbille is also found here. Tiger ,panther, and various kinds of deer, except the moisture loving swamp deer and hog deer are found where patches of dense forest occur.

Chapter IX

FOREST MANAGEMENT

Forestry as a science has been known and practised in some countries of Europe for the last 600 years or more. Germany, France and Switzerland are among the pioneers in this field. In India the birth of scientific forestry took place in 1855. Prior to that there was no scientific management and forests were treated as an inexhaustible source of wood, fuel, fodder and medicinal herbs and plants which were waiting to be exploited as and when, and anyhow, by anyone who wanted to do so. All that the owner of the forest demanded was a certain fee to be given to him on every bullock-cart, ponyload or headload that was removed. Forests were also considered as a hindrance to the expansion of agriculture and all forest land was considered as potential agricultural land and was cleared wherever the increase in the human and cattle population so demanded and where malaria, poisonous snakes and wild animals were less of a menace. During the Moghul period most forests belonged to the king and to the local rulers subordinate to him. Big landlords and zamindars also owned large tracts of forests. They were protected, if at all, only as shikar preserves for the benefit of the rulers and the only control exercised was in the realisation of revenue from those who extracted produce from the forest. Perhaps the only people who were interested in the continued existence of the forests were the rishis and sadhus who meditated there and dacoits and robbers who found shelter.

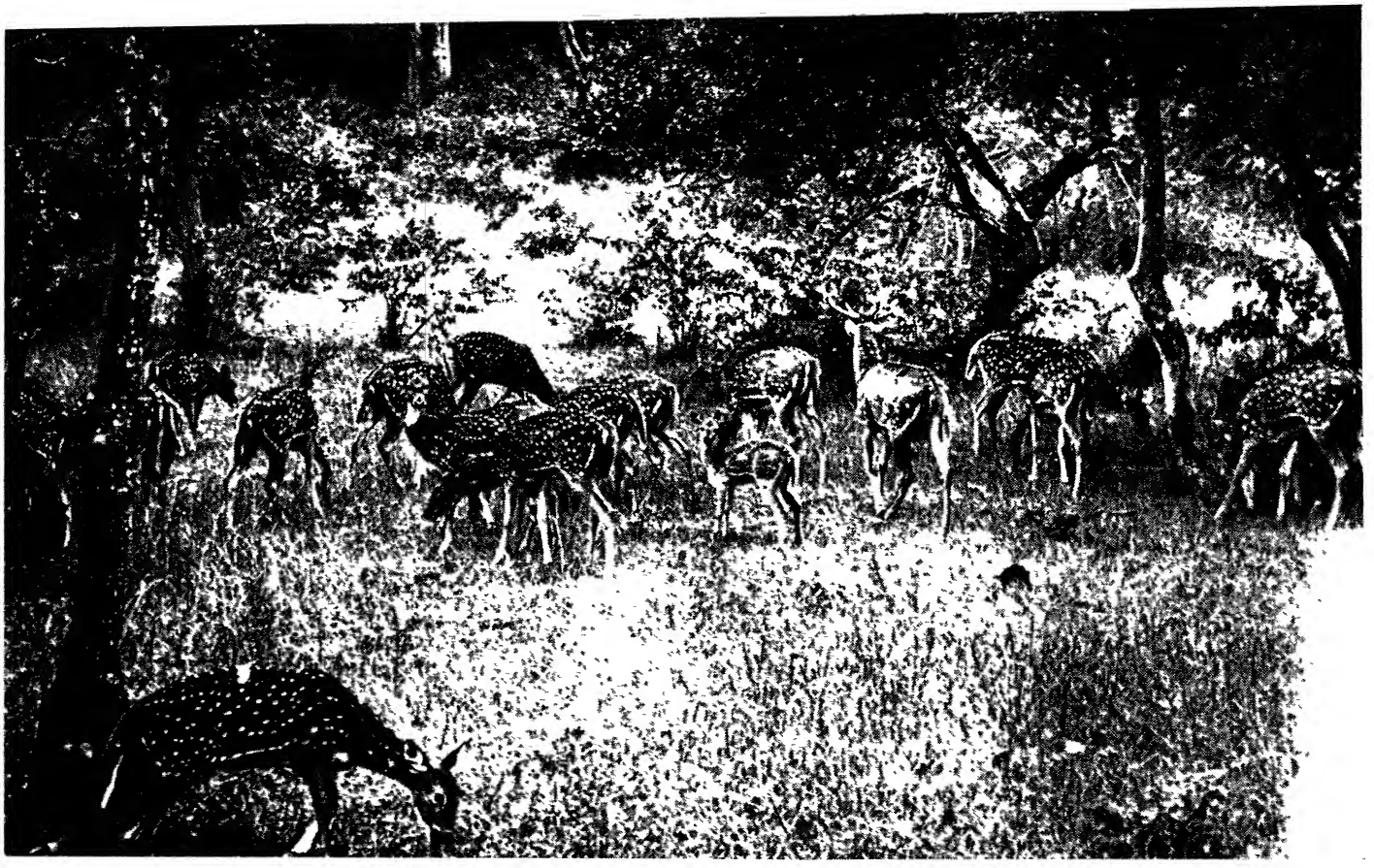
With the coming of British rule in the country, the East India Company created a forest department, the sole purpose of which, in its early days, was to collect revenue on the forest produce collected. This department was manned by officers drawn from the army, the police and other sources who had the physical strength and the courage to brave the hardships and dangers of living in, and looking after, the most backward areas in the country. Above all, they were people who were interested in adventure and shikar There were no trained foresters among them. In fact, professional forestry was not known or taught even in England at that time.

The main objective of the forest organisation of those days was to collect revenue not only from the exploitation of timber and other forest produce but also by leasing out large areas of forest land to big British planters who were prepared to organise the clearing of the forest and putting the land under agriculture or indigo and other plantations. This resulted in large areas of forest land, particularly in the Tarai region of the provinces of Bengal, Bihar and Oudh, being deforested. By the middle of the 19th century the realisation dawned on the Government that forests must be protected and managed scientifically in the same manner as was being done in the European countries and since Britain did not have any eminent foresters who could organise the forest department on sound lines, it was decided to entrust this task to an eminent German forester, Dr. Dietrich Brandis. It was he who conceived the formation of a forest service and in 1867 the Indian Forest Service or rather the Imperial Forest Service, as it was then called, was created with the induction of two young German officers, Messrs W. Schlich (later Sir William Schlich, K.C.I.E., who was to have a brilliant career both in India and abroad) and B. Ribbentrop (later an Inspector General of Forests 1884-1900). It is of interest to mention that out of the first eight people who were recruited to the Indian Forest Service there was one Indian by the name of Framjee Rustamjee Desai. They were trained in forestry at the Forestry School at Nancy in France. It was not till 1901 that

The Fauna

The tiger in its natural habitat.

A lioness in the Gir forests.



A herd of chital grazing in a forest glade.

Wild buffaloes and a pair of rhinoceros in Kaziranga.

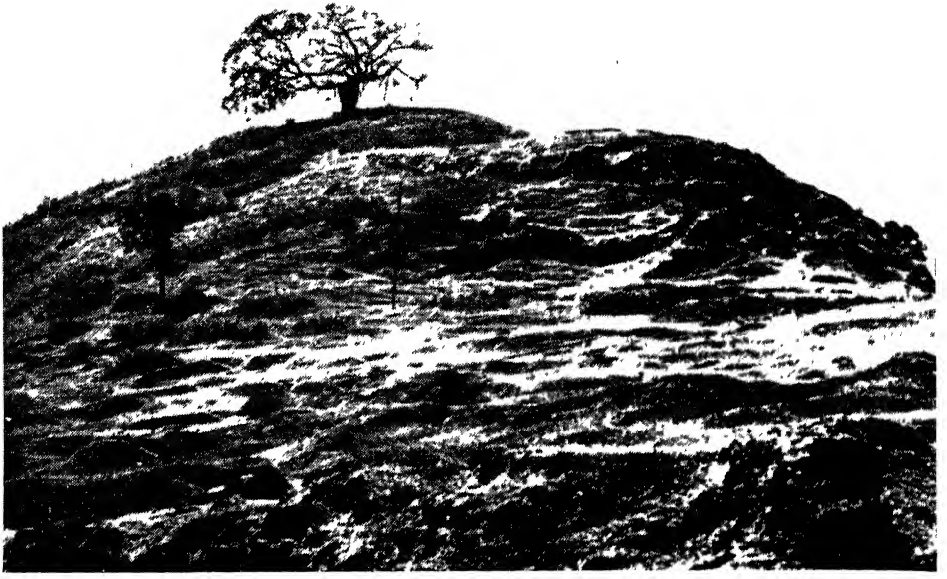
Causes of Denudation

Indiscriminate lopping.

Uncontrolled fellings.

Hacking down forests to make charcoal.

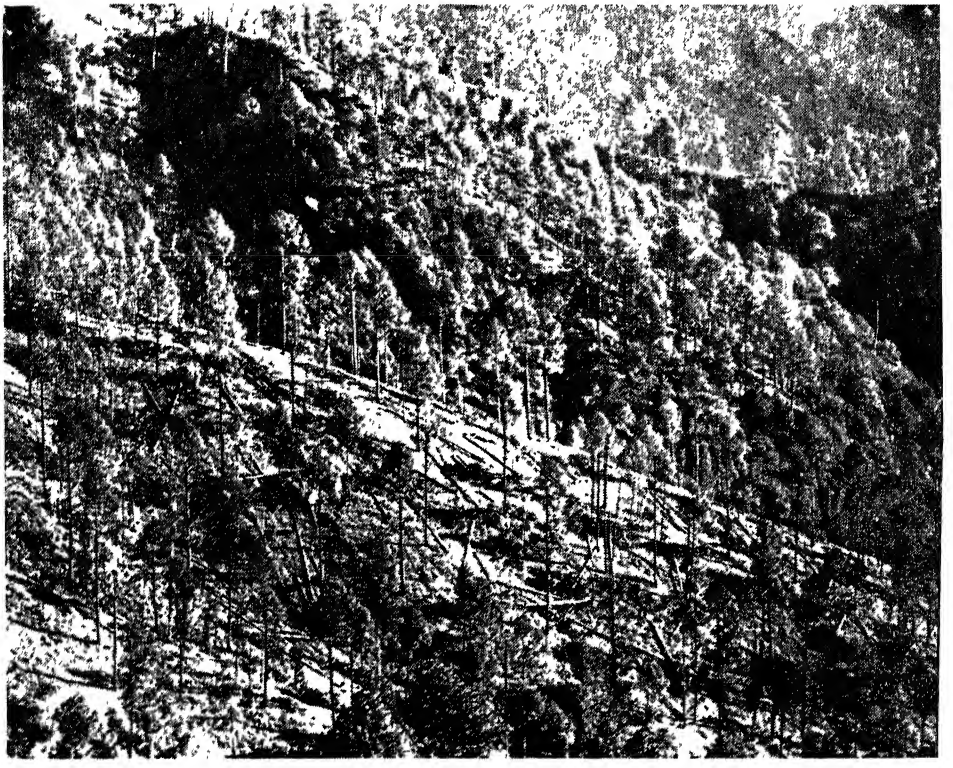
Uncontrolled grazing particularly by sheep and goat.



A denuded hill—most of the top soil has been washed away Note the lone tree on the hill top which shows that the hill was capable of bearing a forest of similar trees

Heavy soil erosion due to denudation of hills Note the heavy sediment deposit in the waterway

Forest Management



Scientific forest management—seeding fellings in a mature chir forest which will result in obtaining natural regeneration.

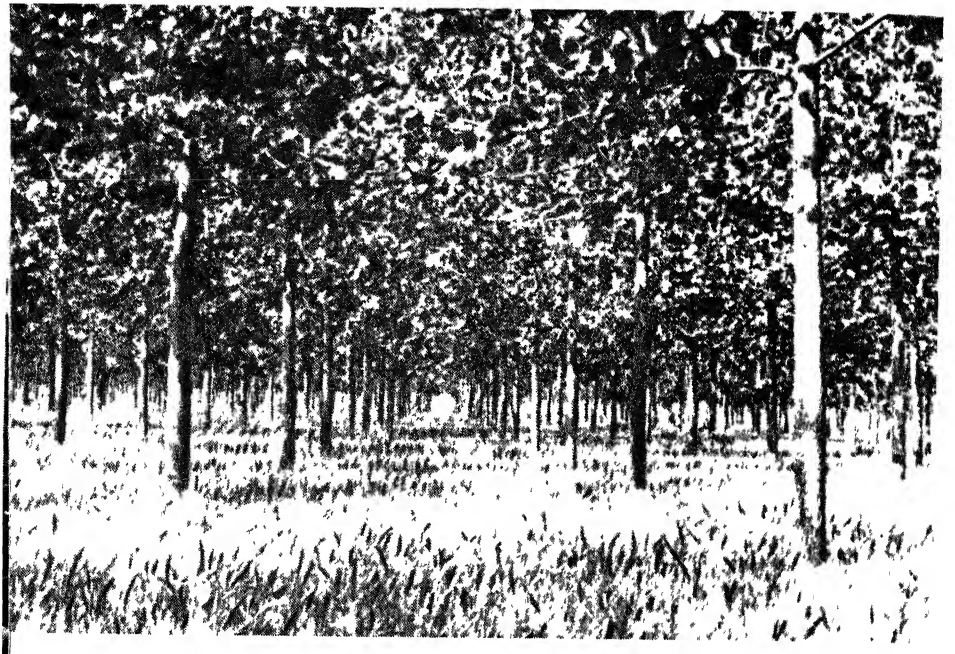
Soil Conservation—a badly eroded slope has been check-dammed from top to bottom. In a few years the slope will be reclothed with vegetation.

Good land use in the hills—the entire hill has been carefully terraced for cultivation. Not a very common sight.

An ideal Himalayan landscape showing well-wooded slopes with only the gentler slopes cleared for human habitation and agriculture. Unfortunately getting rarer and rarer.

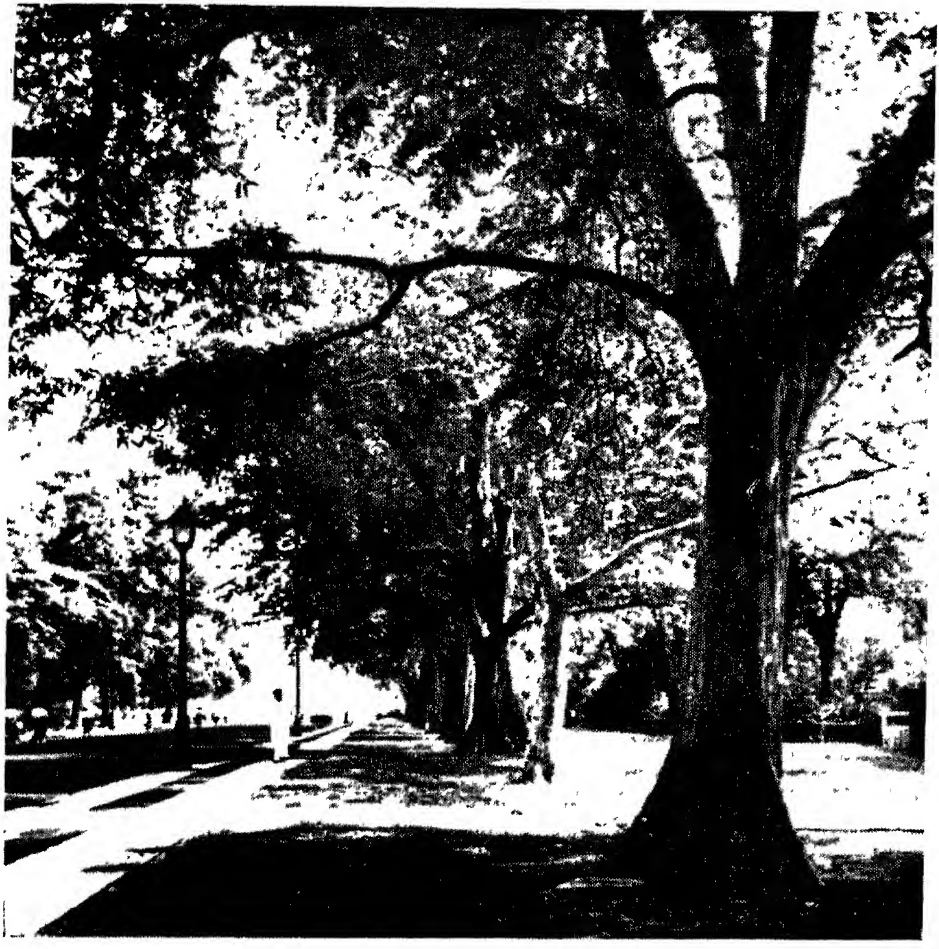
Over sixty-five million tonnes of cowdung cakes are burnt every year as domestic fuel. This could be used as fertiliser if an alternative fuel were available

Agro forestry—Sal saplings being raised alongwith other crops by the taungya method



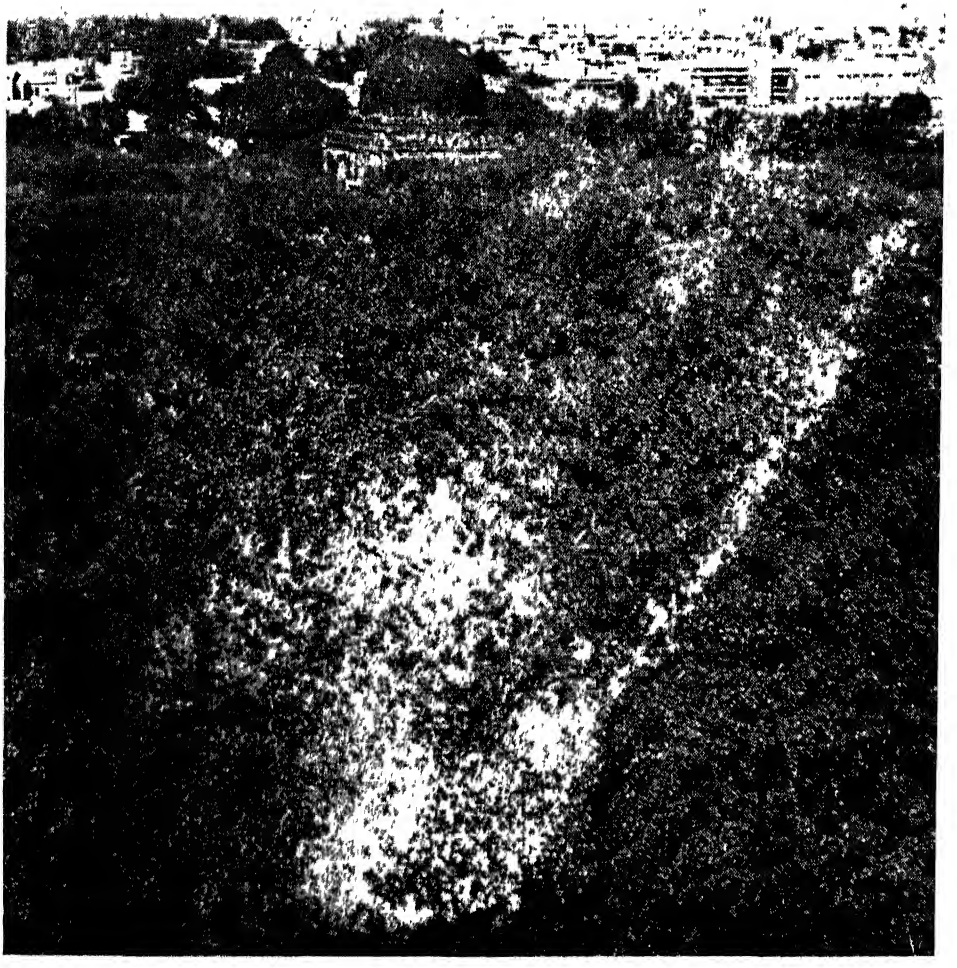
Poplar plantation intercropped with wheat.

An avenue of eucalyptus along a village road.



Trees along a road in New Delhi.

Recreational facilities in the city forest at Hauz Khas, New Delhi (Courtesy—DDA).

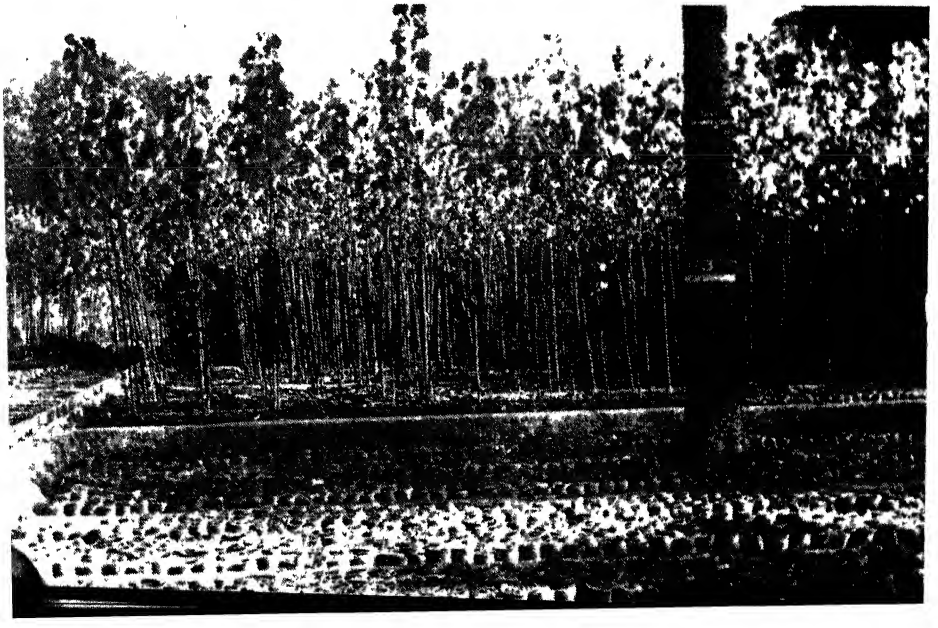


Another view of the Hauz Khas city forest, (Courtesy—DDA).

How to Raise Trees

A forest nursery—seedlings being raised in polythene bags.

Another forest nursery showing poplar saplings ready for being planted.



Britain opened its own Forestry School at the Engineering College in Copper's Hill. It is not commonly realised that of all the Imperial Services or All India Services, as they later came to be known, the Imperial Forest Service was one of the very first to be created.

The first task of the newly created Forest Department was to organise the service into an efficient and effective structure, and surveying and mapping of the forest area. Both were stupendous tasks. It goes to the credit of the infant forest service that it succeeded in accomplishing both these tasks with such competence that even after more than a century the foundations laid by it still holds solid As more and more trained forest officers were inducted into the service the task of working the forest in scientific lines on the basis of working plans or working schemes was taken up.

Another problem that was faced by the Forest Department at that time (and even today) was the question of protecting the forest from illicit fellings, poaching and encroachments. It was realised that the normal law of the land would not be adequate to protect the forest from illegal activities for the simple reason that under the law independent witnesses are needed to prove a case to the satisfaction of the court. In the forest where there were hardly any human beings, it was next to impossible to find independent witnesses to a crime. Consequently a special law called the Indian Forest Act was promulgated in the year 1880 and it is this law and the implementation of it by generations of forest officials that has resulted in the continued existence of our reserved forest to this day.

PRINCIPLES OF FORESTRY

The science of forestry is elaborate and complicated comprising as it does a wide range of subjects such as forest management and silviculture of various species of trees that occur in the forest; forest botany; forest entomology; pathology of wood and tree-destroying bacteria and fungi; histology or the study of

the cellular structure of wood; protection of forests from damage by insects, fungi, wild and domestic animals, fire, frost, rain and snow, and above all from man; logging technique for the proper harvesting of forests; utilisation of forest produce for.the production of sawn timber, plywood and other forms of composite wood, pulp and paper, matches, sports-goods, resin, gum, flowers and fruits which are used in the chemical and pharmaceutical industries; surveying and engineering and wildlife management. In many ways forestry is similar to agriculture because both deal with the growing of plants The only difference is that while agricultural plants are small and short-lived with a harvesting cycle of a few months or weeks, forest plants grow too much larger size on a very much larger harvesting cycle which may run not only into years but decades This presents the forester with a much more difficult task in management and research than faced by the agricultural scientists. Also, the fact that agricultural properties are much smaller than forest properties, the problems of protection against damaging agencies are therefore much more difficult in the case of forest On the other hand, forest plants being hardier and more deep-rooted can withstand excessive rain and drought much better than the more delicate and shallow-rooted agricultural plants.

The principle of management, however, is the same and can be broadly divided into three distinct parts—regeneration, protection and harvesting. The wide range of.subjects that a trained forester has to master, cover all these three facets.

The popular belief that forests grow by themselves and are an inexhaustible source of wood and other forest produce, and all that man has to do is to fell trees when he requires them for his need , is totally erroneous. This belief has come down as a race memory from primeval times when most of the earth's land surface was covered with forests and the human population and its needs were small. Even though forests appear strong and indestructible with tall and magnificent trees, they are in fact a surprisingly fragile complex which, unless looked after carefully, can disappear in a much shorter time than it takes them to reach

maturity A tree takes 80 to 100 years to reach maturity. It only takes that many minutes, or with a modern chainsaw even less, to cut it

Without going into the complicated and time honoured principles of forest management it would suffice to describe the basic principles of proper forest management. To understand them one must realise that every tree is putting on growth from the time it is born to the time when it reaches the age of maturity. This is called increment. The annual increment put on by all the trees in a patch of forest amounts to several thousand cubic metres per annum. This can be compared to the interest put on by a sum of money in a bank, the sum being the total growing stock of the forest. As in the case of money, if the withdrawals from the account do not exceed the total interest earned in a year, the sum still remains safe for all times to come and may even increase if the withdrawals are less than the interest. Similarly, in the case of forest properties if the volume of the total number of trees felled each year does not exceed the total annual increment the total growing stock will be safe forever. This is known as the principle of sustained yield.

The next important principle is that no trees should be felled without ensuring that they are replaced by a sufficient quantity of young growth. This operation, which is of utmost importance in forestry is called regeneration and can be carried out naturally or artificially. The various systems of obtaining natural regeneration followed by the forester all over the world, as also in India, follow Nature's own way of regenerating forests.

It would be of interest to examine what happens in a natural forest without any interference by man. In such forests trees of all ages occur in every patch. There are big, mature and overmature trees with large and shady crowns, young and sub-mature trees competing with each other for sun-shine and young seedlings and saplings existing in patches but not able to grow fast because of being over-shadowed by the older trees. The older trees keep dropping seeds on the forest floor from the time they reach the seeding age to the time their reproductive capacity ceases due to

old age. These seeds are dropped by the million and in course of time a certain percentage of them germinate into seedlings and grow into saplings, patches of which occur under the shade of old mature trees, waiting to grow up but deprived of sunlight unable to do so.

The old trees grow bigger and older and may get affected by disease and their trunks may become hollow. Some day in a storm the big tree falls and suddenly there is a wide opening in the canopy through which sunlight pours on to the forest floor to be eagerly absorbed by myriads of seedlings and saplings. They start growing fast to reach the top canopy and thus the cycle of life continues, the old and aged being replaced by the young and sturdy. Keen competition sets in among the young pole crop for sunshine and soil nutrients and the stronger and sturdier ones suppress their weaker brethren and reach the top canopy to form the future forest. Thus have all forests since the beginning of time, regenerated themselves on this earth but this is a state of affairs which obtains only in virgin forests unworked by man.

In adopting a system of natural regeneration the forester closely follows Nature and only lends it a helping hand. Where for some reasons seedling regeneration is not adequate he creates small openings in the canopy to let in quantities of sunlight necessary for the germination of seeds. He also may undertake cleaning and shrub cutting operations to prevent the young seedlings from being swamped by the forest undergrowth. After a sufficient number of years when the seedlings are well-established and have advanced into the sapling and pole stages, he removes the mature and over-mature trees to allow sufficient sunlight for the pole crop to grow up. Another point that he keeps in mind is that unlike Nature, he does not allow the trees to become overmature, hollow or decrepit before felling them as that is a waste of a natural resources, but fells the trees at an age when they are still sound but their rate of growth or increment is either very slow or completely stopped. There are various methods of natural regeneration followed for

different species and in different areas, which I do not intend to describe here but the underlying principle in all cases is the same.

Now we come to artificial regeneration. In this system a mature patch of forest is clear felled and then planted artificially with seeds or seedlings of the desired species. Weeding, cleaning and shrub cuttings are carried out to help the seedlings to grow up fast and fencing of the entire area is done to prevent damage by animals. In choosing areas for artificial regeneration the forester keeps two important principles in mind—one that the area chosen for clear felling should, as far as possible, consist of mature trees, and two, that the total volume of the trees felled do not exceed the total annual increment of the entire forest unit. The same principle is also followed in doing fellings in areas under natural regeneration. The trees marked for felling should be mature or overmature and the total volume of all such trees felled annually should not exceed the total annual increment. Thus it will be seen that whether natural or artificial system of regeneration is resorted to, the yield taken out from the forest is on a sustained basis and regeneration is adequately ensured so that the forests live for ever.

Perhaps the most difficult task of the forester is to ensure adequate protection to the trees from the regeneration stage right upto the time of harvesting. Very often, well intentioned but equally ill informed people complain bitterly when they see a patch of standing forest being clear-felled. They do not realise that such fellings are absolutely essential for the continued and healthy existence of our forests and are not conducted, as is commonly believed, for earning revenues from the forest. All fellings, whether they are carried out for regeneration purposes or under the thinning operations which are essential for removing congestion among the young crop, are carried out in the interest of maintaining the forests forever under the best conditions of growth and not for making money. The revenue earned is an incidental consequence of silvicultural operations essential for the health and growth of the forests.

The Forest Department with its trained forestry personnel. plays a very important role in managing and protecting our forests. Every State and Union Territory of India has a well-organised forest department usually headed by a Chief Conservator of Forests. Depending on the size of the forest area and the work load, the forests of the State are divided into a number of sub-units called circles under the charge of a Conservator of Forests. Each Conservator's circle is further sub-divided into forest divisions which are looked after by a Deputy Conservator of Forests or a Divisional Forest Officer as he is commonly called. The forest division is divided into ranges under the charge of a Forest Ranger and each range is further sub-divided into Forest Guard's beats. Thus the smallest administrative unit of the Forest Department is the Forest Guard's beat which may vary in size from several hundred hectares to several thousand hectares depending on the terrain, the type of forest and the problems of protection.

The Forest Guard is the basic unit on which the entire forest structure is built. His duty is mainly to patrol.and guard the forests under his control from theft of forest produce, poaching of wild animals and encroachment by villagers. He also ensures that vehicles such as bullock carts, boats, trucks etc. carrying forest produce from the forest do so under proper authority.

The Forest Ranger is the next most important administrative unit, and can be called the key-stone of the forest organisation because he not only looks after the protection of the forest but is also responsible for implementing the silvicultural prescriptions laid down in the working plan, which ensure scientific management of the forest. He has a number of Deputy Rangers and Foresters to assist him in the discharge of his duties. He has to ensure that marking of trees for felling is done properly and what is more, to see that forest contractors or their men do not fell any trees that are not marked and do not cause any damage to unmarked trees during the felling and extraction operations. Under the Indian Forest Act, he has the power to arrest anyone

suspected of committing a forest offence. Apart from this, he has to supervise the regeneration operations, plantation activities and maintenance of forest nurseries. The construction and maintenance of forest buildings, roads and bridges are also his responsibility.

The Forest Ranger is directly responsible to his Divisional Forest Officer who is in overall charge of the forest division, and has to ensure that all Forest Rangers and their staff are discharging their duties correctly. He is responsible for preparing the budget for his division and allocating funds and controlling expenditure in the ranges in his division. One of his most important duties is to see that revenue from various contractors and others is duly realised by the Forest Rangers before allowing any forest produce to go out of the limits of the reserved forests. He enjoys considerable administrative and financial powers, and under the Indian Forest Act, he has the power to compound forest offences.

As mentioned earlier the Indian Forest Act is mainly instrumental in helping the Forest Officer to protect his forests which would not have been possible under the normal law of the land. Forests being located in inaccessible and far away places, lodging of offence report with the police would be difficult and to obtain a conviction under the Indian Penal Code would present many problems. To obtain a conviction from a court of law, testimony of independent witnesses is necessary. Where is the forest official going to find independent witnesses in the depth of the forest? The Indian Forest Act provides the power of arrest to forest officials and of seizure of the illicitly felled forest produce as well as tools, boats, carts, trucks, etc., with which the offence is supposed to have been committed. In case, the culprit admits his guilt and agrees to compound the case in writing and is prepared to pay such compensation as demanded by the Forest Officer, he can be released alongwith his implements, boats, carts, etc., after he has paid the compensation in full. Thereafter, no further action is taken against him. On the other hand, if he refuses to compound the case he is handed over

to the police along with the seized materials and the case proceeds in a court of law. Psychologically, the vast majority of offenders when caught redhanded prefer to compound their offence and pay compensation rather than go to court. The compensation paid is legally not a fine though it amounts to the same or even a larger financial punishment.

The Conservator is the next higher officer above the Divisional Forest Officer, and in many States he enjoys the powers of a head of department in respect of his own circle. It is his duty to see that all Divisional Forest Officers in his circle are discharging their duties properly and the administrative machinery runs smoothly. He has also the powers of sanctioning sales conducted by the Divisional Forest Officer. The Conservator's post in India is older than that of the Chief Conservator's because, originally, each province had only Conservators. Subsequently, as the work-load increased and the necessity of having more than two or three Conservators in a province was felt, the post of Chief Conservator was created for overall supervision of the Conservators' work.

The first post of Chief Conservator was created in the Bombay province in 1905. Thereafter Chief Conservators were appointed gradually in all the major provinces, the last province to have a Chief Conservator was Assam. After Independence the intensity of forest work increased and as a consequence posts of Additional and Deputy Chief Conservators were also created in most states. In some States, where the workload became too heavy with the introduction of departmental logging operations and, of late, the introduction of social forestry on a large scale, two, three or even four posts of Chief Conservators have been created.

At the apex of the forestry organisation in the country is the Inspector General of Forests (IGF). The office of the I.G. of Forests was created as far back as 1864 and barring the posts of the Surveyor General of India is the oldest existing post in the Government of India.

The IGF is the chief adviser to the Government of India on all matters relating to forestry and wild life. The forest organisations in the Union Territories as well as the Forest Research Institute and Colleges with its branches are under his direct control. He is responsible for the planning and implementation of all projects concerning forestry research and education. He represents India at all international conferences and is responsible for negotiations in connection with aid received from various counrties and from world bodies such as the Food and Agricultural Organisation and the World Bank.

Prior to the introduction of the Government of India Act 1935 under which forestry became a provincial subject, the Inspector General of Forests enjoyed executive control over all the provinces including the appointments and transfers of Conservators and Chief Conservators. While the State Forest departments are no longer under his direct administrative control, he acts as their Chief Adviser and the advice tendered by him carries great weight. He examines all Plan schemes of the States and processes these with the Planning Commission. He also allocates funds and physical targets to the States in respect of centrally sponsored schemes.

The I.G. of Forests also coordinates the demands of the forest based industries and advises the States on the quantities and prices of raw material to be supplied to various industries.

With such a well organised and time-tested forest administration in the country having a history of more than 125 years, why is it that our forests are being depleted? Is there something seriously wrong with the forest administration or is it that the forest officer in India is not discharging his duties properly? To go into these questions, one must look into the history of the forest department and examine the socio-political changes that have taken place in the country since Independence.

From its very inception and even to this date the Forest Department has been entrusted with looking after and managing reserved forests belonging to Government and in this task they have acquitted themselves with credit. Had they not done so,

the vast areas of reserved forests which are in existence in the country would have disappeared a long time back. In administering these forests the Forest Department in India is second to none in the world. However, where the Forest Department has failed in preventing the destruction of the forest cover in the country, are the areas which lie outside the limits of the reserved forest. It must not be forgotten that prior to Independence, large areas of forest were under the control of the princely states, rajas and zamindars and big landlords. The Forest Department had no legal power of controlling or protecting these forests. After the merger of the princely states and the abolition of zamindari all over the country, most of these forests were destroyed and put under cultivation. Those that were handed over to the Forest Department for management could not be declared into reserved forest even to this date due to political pressures with the result that while theoretically the Forest Department was responsible for protecting these forests, it has no legal power to do so. Also, in many States the expansion of the forest administration to cope with the additional burden that suddenly descended upon them, was not adequate or timely.

Chapter X

DEFORESTATION — THE PROBLEM

It is common knowledge that India's forests and tree cover are disappearing at an alarming rate. This is a matter of great concern not only for the present generation but for posterity. The recorded area of land under forests in India is 75 million hectares, and till 1974 almost five million hectares of forest land were deforested by the various State Governments. The quantum of actual deforestation till 1980 would be much higher than the above figure because the formalities involved take time and the records are yet to be brought upto date. Added to this deforestation, which has taken place legally and under the orders of the State Governments for various multipurpose projects, resettlement of oustees and displaced persons and for providing land to the landless, there is a sizable area of illegal deforestation carried out by encroachers, illicit fellers and graziers. Forest contractors are also responsible for removing a significant number of trees over and above the legitimately marked trees. While this may not be true of all States and of all contractors, in some States the problem has achieved serious proportions and consequently, the State Governments are rapidly giving up the practice of harvesting through contractors' agency and replacing it with departmental extraction, either through the State Forest Departments or through the State Forest Development Corporations.

The forests in our country have been steadily denuded during the last 30 years. Clearing of forests for agriculture and for other uses has been a common phenomenon in the past, but

during the last 30 years or so the rate of deforestation and denudation has been dangerously rapid. The reasons for this are :

(i) The tremendous increase in the human population which has resulted in the need for more and more land for agriculture;

(ii) Along with the increase in the human population there has been a corresponding increase in the population of domestic animals such as cows, buffaloes, sheep, goats, camels, horses and donkeys. These animals are allowed to graze freely and indiscriminately all over the forest and village grazing lands, without any consideration to the maximum number of animals that the land can support. This results in overgrazing of the grass and even the trees and their seedlings are not spared. Consequently, the forest cannot regenerate and ultimately dies off.

(iii) Added to the above factor is the great demand for land for putting up irrigation and power projects, factories, roads, canals, schools and colleges, etc., for which the choice very often falls on forest land because, in a heavily populated country, such land seems to be the easiest to acquire. This is very shortsighted policy in a country where the forest area is already well below the desired minimum. Further encroachment on forest land will only spell disaster for the future generations.

(iv) One of the most important factors for the steady denudation of our forest areas is the poverty in our villages. Many poor people living near the forest, steadily and indiscriminately, cut trees in order to earn a living from the sale of firewood. Trees and bushes growing on village waste lands are also being steadily denuded. The same or even a larger amount of wood could be obtained from the same area if the forests were maintained properly and the cutting carried out in an orderly manner.

(v) Before the abolition of zamindaris and princely States, a large area of forest was owned privately by zamindars, landlords and rajas. Most of these forests were strictly protected and maintained as hunting grounds and contained a rich variety of wild animals and birds. They also provided timber, firewood, thatching grass and other forest produce to the local inhabitants. With the abolition of landlords and rajas, these forests reverted to the control of Government and in the process of this transfer, large area of forest got deforested and converted into agricultural lands, and the forest cover with its rich wild life disappeared.

(vi) In some parts of our country, specially in the north eastern and the central Indian region, the local tribals practise shifting cultivation. This consists of clear felling a forest area, burning all the felling refuse and then sowing agricultural crops. The rich forest soil combined with the ash from the burnt material, yields good agricultural crops for a year or two. Once the fertility of the soil has been washed off the area is abandoned and a new clearing made. This is a very wasteful and primitive practice which did not matter in the olden days when the tribal population was small and the forest area enormous. With the increase in population in the tribal areas, more and more land is being put under shifting cultivation with the result that the rich forest cover in these areas is being steadily denuded. The cultivator has to come back to the same area after a short interval before the forest has had the time to regrow and enrich the soil again. Consequently, the agriculture yield is poor and the poverty of the tribals is increasing.

(vii) Above all, the most serious and potentially dangerous cause of widespread deforestation and denudation in the country is the total lack of a genuine desire to protect forests at the political and administrative

levels. This is despite public utterances to the contrary and a great deal of lip service to the cause of forestry. It has become very common for those responsible for administering the country to speak strongly against deforestation and even to issue orders and promulgate legislation to prevent further denudation of forests and at the same time give away large areas of valuable forest land for non-forestry purposes on the grounds of political or administrative expediency. Every irrigation or multipurpose project that has come up in the recent past or is going to come up in the near future, has invariably resulted in large scale deforestation not only for the project itself, which may be unavoidable to a certain extent, but also for resettlement of oustees from the project area as well as the command area. In providing land to the displaced persons, the principle of giving land for land is adopted with a vengeance. So much so that every oustee is given a minimum of 2/½ acres or more even though his actual land submerged may be a tenth of an acre. In some States forest land is given along with the standing trees and the choice of the area is left to the villagers with the consequence that the best forests are often cut down for resettling the oustees instead of resettling them in degraded forests or lands from which forests have already been hacked and removed.

With the increase in population, the number of landless people is increasing and there is a constant pressure for providing land to them by cutting down forests. It is not realised that this is no solution at all to the problem, and even if all the demand for land by the poor and the landless is satisfied by sacrificing enormous areas of forest land today, the problem will remain the same after 10 to 20 years. If the principle of providing everyone or every organisation that needs land by cutting down forests is allowed to continue,

in a few decades all forests, except those on very steep slopes and very poor soils would disappear and the country would take an irreversible step towards total desertification. Unless there is a strong political will backed by widespread public consciousness in favour of protecting the country's forests, no amount of afforestation or plantation would be of any use in preventing the environmental degradation of the country.

Chapter XI

AND THE SOLUTION

From what has been said in the previous chapters it is obvious that indiscriminate deforestation and denudation pose a serious threat to the country's environment and climate. Increased soil erosion, frequent floods and droughts and lack of water for irrigation or even drinking purposes during the dry season, seriously endanger agriculture, and if permitted to continue unchecked can spoil the quality of life in our country. However, it is not too late to take steps to halt and reverse this process of environmental degradation.

The solutions are simple but their implementation is difficult unless there is a general realisation among the people of the country, particularly the people living in the rural areas and above all the politicians and the administrators, of the importance of forests and the dangers of deforestation. The children and the youth of the country have also got to be made aware of the importance of forests. Once such a realisation is widely aroused and the people start treating forests and trees with love and respect and consider them as a source of long term benefit to mankind instead of one of short term gains from wood and fodder, or a hindrance to the expansion of agriculture for the advantage of a few individuals, the situation can be controlled and improved. In the countries of Europe such a realisation exists. So much so that not a single tree is allowed to be felled unless it is mature and is replaced by several seedlings to take its place. Forests exist even upto the door-steps of large towns where land value

is high and the temptation to use the land for building houses and factories is great. The people of these towns themselves strictly guard these forests because they know how valuable they are in maintaining the quality of life and the beauty of their environment.

The most important step that requires to be taken is the protection and maintenance of the existing forests and tree growth whether owned by Government or by private owners. At present, less than 23 per cent of the country's land area is under forests, when according to our National Forest Policy, 33 per cent of the area should have been forests. So, obviously the first step is that the existing forest area should be jealously guarded and scientifically maintained so that it can produce timber, firewood and numerous other forest produce on a sustained basis. While the Forest Departments of India are doing this job to the best of their ability and there is a special law for protecting the forest, complete protection of such a vast property is not possible without the help and co-operation of the people living in the area. Millions of hectares under agricultural crops are immune to damage by cattle or human beings without any fencing or guards. Why? Because of the force of public opinion and will. No villager will allow his cattle to graze in his neighbour's field nor will other villagers tolerate it. The result is complete protection. Similar protection can be afforded to the forest if the local people accord the same respect to the forest crop as they give to the agriculture crop. This requires education of the rural population to make them realise, the long and short term benefits of protecting forest growth.

Haphazard and indiscriminate grazing and browsing by millions of scrub cattle and indiscriminate lopping of forest trees for fodder must be stopped and replaced by controlled grazing and stall feeding of a smaller number of better quality cattle and animals. One good quality cow can yield more milk than 10 poor quality animals and yet will not consume even half the fodder. The number of animals allowed to be grazed in any area should not exceed the carrying capacity.

At the same time it is very important that the existing forest area should not be given over for non-forestry uses. As we have seen earlier, out of the total forest area of 75 million hectares in the country, we have lost almost five million hectares of forest land in the last 30 years. No further forest land should be spared except where absolutely unavoidable.

Apart from the above preventive measures, the most important task is the large scale of afforestation of all bare waste lands and reforestation of degraded forest lands through a massive country-wide plantation programme. There is no shortage of land in our country and vast areas of land are lying almost bare and unutilised except for grazing by poor quality cattle or raising of a scanty agriculture crop. Such lands if put under trees or under grass lands and properly managed could produce far more benefit.

While the existing forests which are owned by the Government and managed by the Forest Department of each State should continue to be protected and scientifically maintained to yield the maximum amount of forest produce on a sustained yield basis under what we call Production Forestry, all waste lands and degraded forests, whether owned by the Government, village communities, public bodies or by individuals, and all available land along roads, paths, railway lines, canals and irrigation channels should be planted up with trees under a massive social forestry programme.

Chapter XII

SOCIAL FORESTRY

Social forestry or forestry for community development is a new concept of forest creation, management and utilisation of goods and services generated therefrom for the benefit of the society. Among the prime human necessities are food and shelter, and for both these needs forestry can contribute substantially.

For cooking food, energy is required. In rural India, in the absence of any regular source of processed domestic fuel, 95 per cent of the fuels comprise firewood, cowdung and agricultural wastes. Planners in India know that the diversion of cowdung, farm wastes, etc., to agriculture would result in higher agricultural production besides arresting growing aridity of the climate and soil erosion. The villager, although aware of the importance of cowdung and compost as manure, is helpless because he has no alternative fuel within his reach. The social opportunity cost of burning huge amounts of soil nutrients each year is considerable. A rupee spent in replacement of cowdung or farm wastes means an indirect earning of Rs. five to Rs. ten in the way of production of additional food crops. Some energy survey estimates provide the following orders of consumption during 1975-76 in the rural areas :

(i) Firewood and charcoal	140 million tonnes
(ii) Cowdung (dry)	75 million tonnes
(iii) Farm wastes	40 million tonnes

The Fuel Policy Committee estimated the fuel demand for domestic sector for the years 1978-79 and 1990-91 as follows :

ESTIMATED CONSUMPTION OF FUELS

(figures in million tonnes except in col 5 and 7)

Fuels	1978-79	1990-91	Estimated consumption in coal replacement			
			1978-79	As a percentage of the total	1990-91	As a percentage of the total
	2	3	4	5	6	7
Commercial						
1. Soft Coke	5	20	7.5	3.096	30.00	9.927
2. Kerosene	3.5	6	29.05	11.956	49.80	16.478
3. L.P.G.	0.4	2	3.33	1.366	16.61	5 497
4. Electricity	8 b.kwh	25 b.kwh	8.00	3.292	25.00	8.272
			47.88	19.710	121.41	40.174
Non-commercial						
5. Firewood & wood for charcoal	132	122	125.40	51.61	115.90	38.350
6. Dung cake (dry)	65	53	26.00	10.70	21.20	7.015
7. Vegetable waste	26	46	43.70	17.98	43.70	14.459
			195.10	80.29	180.80	59.824
			242.973	100.00	302.214	100.00

Most commercial fuels, other than hydro-electricity, being practically non-renewable are exhaustible. With the passage of time these stocks are bound to dwindle. Consequently, with the increase in population and rise in the per capita income, the demand for commercial fuels will increase. Efforts are needed to replace the use of exhaustible fuels with those which are renewable. Also, conditions should be created so that enough

wood fuel is available to divert the cowdung (10.70%). and vegetable waste (19.98%) to the farm as manure. The high social cost of using cowdung and farm waste as fuel has brought the importance of wood—a renewable, versatile resource—to the forefront. Tree growing requires land and human resources. In India we have no dearth of these. Unutilised scattered land and unemployed masses in rural areas are abundantly available. Social forestry is the answer to utilise rationally these natural resources hitherto not fully harnessed.

The beneficial role of green vegetation on soil management and erosion control is universally acclaimed. Faulty cultivation of the hill slopes, shifting or jhum cultivation combined with large scale deforestations, road buidling, colonisation, etc., in the catchment areas of our main rivers have caused serious erosion and imposed a heavy cost on the society. The eroded material has been filling up the river beds year after year and is causing severe floods. Flood control and relief measures impose a serious drain on national resources Recurring losses of life, live-stock and property remain largely uncompensated.

China offers a spectacular example of how during recent-times, through planned and concerted mass planting efforts and farm forestry practices, it has succeeded in curbing the annual depredations of their rivers of sorrow such as Yangtze Kiang, and Hwang Ho. Extensive forestry programmes (over 105 million hectares) have helped China to minimise flood havoc by consolidating river and stream catchments. The land thus salvaged is restored to the communes for cultivation.

Social forestry aims at combining the idle land (including solar energy), labour and water resources to the best interests of the society in such a manner that the community becomes self-sufficient in food, farm manure, firewood, fodder, small constructional timber, fruits, flowers and seeds, etc., and the soil is protected against water and wind erosion on a sustained basis. It calls for various permutations and combinations of forests, trees with food crops, horticultural crops, live-stock for meat and dairy.

Such composite utility of the solar energy through vegetative growth promotes material growth as well as ensures the protection of local environment and ecology. Recreational and aesthetic amenities of the tree cover are the by-product of social forestry which further ameliorate human surroundings. From the planning standpoint, agriculture, forestry and animal husbandry are equally important and interdependent. Social forestry is, in effect, an integral part of the Gandhian philosophy of economic growth and community development. Imagine the economy in which the present idle land and water resources, owned by individuals or communities, are combined with the idle human resources, with the above objectives. The social benefits generated and the self reliance achieved as a consequence would be tremendous.

A conceptual distinction has been drawn between production forestry and social forestry although both generate social benefits. Production forestry aims at producing timber and wood for industrial uses. The objectives of social forestry as defined by the National Commission on Agriculture are : (i) fuel wood supply to replace cowdung, (ii) small timber supply, (iii) fodder supply, (iv) protection of agricultural fields against winds, and (v) recreational needs Its main components are : (i) farm forestry, (ii) rural forestry, and (iii) urban forestry. These components, although having common objectives, are discussed below in some detail.

FARM FORESTRY

The concept of farm forestry formulates the technology of advantageously combining agriculture with forestry. It is an innovation with far reaching significance and envisages the introduction of a green revolution in India's agricultural economy. As it is, our agricultural economy is lop-sided. We produce food but due to acute scarcity of firewood resources, we burn extensively cowdung for cooking and heating. Cowdung with litter and green leaf makes an organic manure which serves as a life

blood to the soil. As a result of large scale burning of cowdung there is a continuous depletion of phosphorus, potash and nitrogen from the soil, adversely affecting its fertility. The author estimates that over 458 million tonnes of wet dung are diverted annually to the rural hearths in India. At five tonnes per hectare this dung could fertilise 91 million hectares of land. Assuming an additional yield of five quintals of food per hectare, the annual loss of food is thus estimated at 45 million tonnes valued at Rs. 45,000 million. The release of cowdung for its legitimate manurial use in the field and the creation of firewood resources within the farm itself is the main objective of farm forestry.

In addition, farm forestry also aims at diverse benefits to the farmer: (a) building up his balanced economy and self-sufficiency, (b) providing firewood, small timber and fodder, and (c) as an extra source of revenue. Physically a vegetative belt helps stabilise soil, conserve soil moisture and prevent air and water erosion.

Trees planted on farm bunds ordinarily serve as fence between two plots and also as shelter belt in desert prone areas. In chronically drought affected areas agricultural lands get sanded periodically, the dry winds cause excessive surface evaporation thus creating moisture stress against the agricultural crops. Wind breaks of trees and bushes judiciously planted can save the land from degradation and help to better soil moisture and fertility. In areas where sand casting is a regular feature, wind breaks serve as effective checks thereby preserving the land's suitability for agriculture. Impressive work of this nature has been demonstrated in Mohindargarh district of Haryana where by creating systematic wind breaks, sand intrusion from Rajasthan has been substantially checked. Outstanding work has also been done under the social forestry schemes in the States of Gujarat, Tamil Nadu and Rajasthan.

The advantage of farm forestry to rural economy are calculated to accrue without impairing the quantity and quality of the normal yields from the fields. However, the choice of forest species and a general lay-out of trees and agricultural

crops in a farm are of vital importance for the mutual success of field crops and trees. The extent of adjustment needed in a locality depends upon the type of soil, rainfall, temperature, soil moisture, wind conditions, etc. (A list of tree species suitable for social forestry programmes in general and farm forestry in particular is given in the Appendix II). Nevertheless, it is hoped that the experience gradually gathered by the farmer in due course of time will enable him to use his own discretion in this matter with better practical results.

To achieve the requisite degree of allround self sufficiency, all that an individual farmer has to do is to plant suitable tree species/bushes within his farm in such a pattern as to avoid any risk of inter-encroachment between field crops and the forest vegetation. The system of dual cultivation will not deprive the farmer of his freedom to harvest his field crops in due seasons. Only in the case of tree/bush crop he will have to extend the time horizon, in the initial stages, to about five years for receiving direct monetary and material returns from the trees/bushes. Once the cycle starts, then the yield and return from the latter source worked in replicated order also becomes an annual feature.

The returns from farm forestry practices show marked increase against those from seasonal crops. The cumulative production of field and forest crop leads to greater benefits and a more judicious use of the farm land. A farmer, given the technical know-how and the seedlings of the required species. can derive optimum benefits from the trees. The yearly employment generated is also very high.

Farm forestry has the potentials of becoming a reality in India's practical agriculture. Some progress in this direction hitherto made by some of the States is worth mentioning. One of them is Gujarat. Some case studies conducted on farms practising farm forestry have shown very interesting results. A case study of the Vatava Farm near Ahmedabad belonging to Shri Kalidas Patel has shown that the financial internal rate of return (FIRR) to the farmer is an unbelievable 89 per cent

if the seedlings are provided free by the Forest Department and 78.5 per cent if the cost of seedlings is borne by the farmer.

The Vatava farm forestry model has been extensively copied. In 1977, 86 farmers planted 752 hectares with Eucalyptus, while in 1978, 300 farmers had requested the Forest Department for the free seedlings. The farmers have started appreciating the value of thus diversifying their operations beyond the conventional short duration crops.

Some misgivings against farm forestry

The main prejudices against tree planting on farm land are :

(i) that the trees harbour birds which damage food crops;
(ii) that trees provide shade which suppresses crop growth; and,
(iii) that trees lead to lowering of the ground water table through excessive transpiration.

The prejudices are misplaced and can scarcely hold against the following fact :—

Birds: Birds stand in a class by themselves as destroyers and natural checks on harmful insects, pests, rats and other vermins. Birds feed largely on insects, worms and caterpillars. Caterpillars devour leaves twice their own weight per day. Birds such as white stork (Ciconia ciconia) not only take a heavy toll on caterpillars and locusts but also scratch up and devour insect eggs in vast quantities. Many birds such as the rosy pastor (Sturnus roseous) live and feed their young exclusively on insects. A German ornithologist has estimated that a single pair of tits with their progeny destroy annually at least 120 million insect eggs or 150 thousand caterpillars and larvae. Owls, eagles, hawks and other birds of prey are Nature's important checks on rats and rodents.

Shade from trees: The idea that the shade of the trees

is harmful to the crop may be true in certain circumstances. Large scale experiments carried out in Ukraine, USSR, in the 1950's indicated that the agricultural losses due to trees were off-set in two years in case of poplars and five years in case of oak plantations, ultimately resulting in an increase in weight of herbage as well as in the yield of wheat. However, to avoid a conflict between trees and field crops, a mutual adjustment of trees and field crops is of paramount importance. For this, a discreet selection of tree species and their spacing in a farm is always advocated. The tree species selected, and their disposition on farm land should be such as to obviate shading.

Water consumption: Trees replenish the ground water during the monsoon through increased absorption. In Punjab, Haryana and Uttar Pradesh where Eucalyptus tereticornis has been grown along road sides, canal banks and on field bunds, high yielding wheat crops are being grown with encouraging results. Scientific data on water consumption habits of trees and agricultural crops are not available. Proper studies of this aspect may be useful for the reassurance of the farmer. In any case, individual farmers having prejudices against particular tree species may plant alternative species. Planting of jamun trees in a row along the field bunds in Saharanpur district of Uttar Pradesh, shisham trees on field ridges in West Dinajpur, eucalyptus in Punjab and Haryana and of casuarina trees in sandy soils in Orissa and the South, bear testimony to the fact that no significant damage is caused by trees to the field crops. In Saharanpur and West Dinajpur, the practice of planting trees on farm bunds is very old.

The Vatava farm has demonstrated that absorption capacity of the soil in the tree planted areas increases. In the year 1976, about 304 mm of rainfall was absorbed in the farm in a few hours, while water in the neighbouring farm (treeless) stood for 4-5 days after the rains. This shows that trees recharge the sub-soil water more efficiently thereby mitigating the rate of transpiration vis-a-vis seasonal crops.

Role of the farmer

As a first step towards farm forestry, the farmers can confine to grow their own timber, fuel and fodder trees along field bunds, wasteland, and marginal land where cultivation is not possible. The farm bunds are made to demarcate one area from another and collectively occupy enormous areas of land. The total area of the cultivable land in Uttar Pradesh, Haryana, and Punjab is estimated at 34,047,000 hectares. Taking a paltry one per cent under bunds, the total land coverage in these States is estimated at 340,470 hectares or 34,047 Sq. Km. This otherwise unproductive area could be utilized for growing more than 90,769 million trees. All that the individual farmer has to do is to dig pits 1.25 metres apart in a single row along his field boundaries, obtain good sturdy plants of his choice, from the nearest Forest Department nursery, and plant them in July or August. No special protection is needed since the plants will get automatic protection while Kharif and Rabi crops are standing. By the time the Rabi crop is harvested these plants become sufficiently tall and sturdy to be above damage level. They will need no extra irrigation as the irrigation given to the food crop will benefit the plants also. Fertilisers, leaching below the crop root level would be utilised by these trees. With a close spacing of trees (Eucalyptus) and considering a rise in prices the present income would be about Rs. 50-100 per tree or about Rs. 2500 to Rs. 5000 per hectare in a 10 year period.

Needless to say, trees are a cash crop with a distinct advantage over the traditional agricultural cash crops; the product is not perishable. If at any time, the owner does not get the expected price, he need not harvest his trees; the trees will put on valuable growth and the owner can always sell them when the market conditions are favourable. As against tree crops, in the case of agricultural cash crops the farmer has no alternative but to harvest them, irrespective of the market conditions. Similarly, when in dire need of money, the farmer can always cut the tree and get money quickly.

The greatest advantage of a tree crop over an agricultural crop is its capacity to tolerate the vagaries of Nature Too much or too little rain hardly make any difference to a tree crop except perhaps in the first year. Hail or storms also do not damage it to the same extent as they would an agricultural crop. Trees have also got a much higher immunity against insects and fungal attacks. In short, a tree farmer can sleep in peace while his crop grows unlike the agricultural farmer who has to worry about storms, heavy down pours, prolonged droughts and attack by insects and fungi.

The resources of the State Forest Departments are inadequate to plant up and maintain all the vacant private lands in the country. Through farm forestry this responsibility is decentralised and the tree resources thus created are better protecte and managed due to individual ownership. From the social point of view farm forestry provides the quickest means of increasing the country's tree resources and forest area.

The green revolution in agriculture envisaged cannot be achieved without the farmers' self-sufficiency in fuel, fodder, manure and small constructional timber. There is a prima facie need and urgency to educate the farmers and villagers on the beneficial role of forestry as a handmaid of agriculture. They must be told that their salvation against a lop-sided economy lies within their own easy reach. The principles of farm forestry must be imbued in them both mentally and manually.

RURAL FORESTRY

Also called extension forestry, it encompasses forestry on community and panchayat lands, degraded forests and along roads, railways and canal banks for meeting the needs of the rural people. It also includes restoration of derelict areas bearing scars of quarrying, mining, road construction, brick manufacture, lime burning, etc.

The objective of rural forestry are similar to those of farm forestry; meeting the needs of the rural masses. There is,

however, one important difference. This is with regard to the ownership of the land. In farm forestry the ownership of land is ordinarily individual while in rural forestry it is communal. This difference in ownership poses peculiar protection problems and needs the involvement of the community as a whole for the effective implementation of the projects.

Rural forestry requires the involvement of the rural masses in a big way. It is they who can contribute to the overall economic development of the region and also share the benefits. Systematic involvement of the rural masses will bring to the forefront the multiple advantages of trees for food, fodder and subsidiary products.

A number of cottage industries can develop with the aid of tree resources. Among these are honey, sports goods and silk, oil from seeds of mahua, neem, kanji, paper from saijan wood, household furniture from shisham, babul and even eucalyptus, dairy industry from fodder, etc.

The ethos of rural forestry is bound to induce public interest in the well-being of public owned forests. Once the farmer is assured of his own self sufficiency in fodder, fuel and timber from his own land, he is not likely to encroach upon public owned forests. The changed circumstances will go a long way to lift illegal pressure against public forests which, at present, constitute a serious threat against them.

Idle land resources

Social forestry aims at growing of trees singly, in groups or in strips. Its object is also to carry out planting of trees wherever possible. At present, among others, the idle land resources consist of road sides (length over 12,24,000 km), sides of rail tracks. (length over 59,790 km) canal banks (length over 1,50,000 km) and drainage channels (length over 20,000 km). These alone offer over 9,02,000 hectares of land that could be profitably planted. Other waste lands are: river banks, degraded areas in villages, ravines, swamps, cremation grounds

and compounds of schools, colleges, hospitals, buildings, etc. In India, an area of about 43 million hectares is classed as either uncultivated, non-agricultural and barren land. These degraded areas mostly represent land deprived of their erstwhile natural vegetation. The bulk of these areas is amenable to the regrowth of trees. Out of the 75 million hectares classed as forests, a significant chunk represents decrepit forests and stands in need of rehabilitation. At the same time, there are about 220 million people, mainly in the rural areas, who are living below the poverty line because they are either unemployed or under-employed. These idle land and human resources can be productively employed, given appropriate technology, choice of suitable tree species and a moderate investment to create forest resources in the rural areas. Given the land and human resources, forestry does not require much investment, high skill or sophisticated machinery to generate the much needed rural employment and income.

Broadly speaking, one hectare of plantation activity, depending on the area, species selected and the spacing adopted, generates 150 to 500 man days of employment in the rural areas during the first three years. Later, the harvesting of the forest crop, provides employment at a higher level of income for almost twice the number of man days. Harvesting in the 6th and 10th years provides scopes for greater employment. Subsequent periodic thinning operations generate more employment possibilities. This is when the secondary employment in the processing of wood and other forest products due to their extensive forward linkages is not considered.

Road side plantation activity can be as labour intensive as demanded by the local conditions and the technique of planting. For example, in the case of mound planting needed in saline or water logged areas, the employment potential varies from 614.36 man days to 632.18 man days at 330 plants per hectare equivalent to 330 plants per row kilometre, depending upon the size of the mound. Circular trenches having internal and external diameters of 1.8 m and 3.6 m, and a trench dimension

of .9 m x .75 m x .60 m, having plant pit of .6 m x .6 m x .6 m. generate 568.67 man days of employment per row kilometre in the very first year. For simple pit road side planting, the corresponding employment per hectare varies from 386.26 to 431.14 man days. The total employment, generally will, however, rest on the socio-economic conditions prevailing and the cooperation of the rural masses in any particular locality.

Although, the road side plantations (because of their numerous externalities such as shade and aesthetic values, their functioning as shelter belts, environmental and ecological protection mechanisms, which are not paid for) are not generally expected to yield commercial returns comparable to the market rates on investment, yet some case studies conducted in Haryana and Punjab show that road side plantations are financially viable. FIRRs (Financial Internal Rate of Returns) from 13 per cent to 32 per cent have been estimated.

The planting of trees in groups or strips in village areas, also show encouraging financial returns. Results of benefit-cost analysis of some village plantations in Gujarat and Haryana States, show that even in saline and non-irrigated soils, the FIRR is 7 per cent in addition to other amenities offered by the trees.

URBAN FORESTRY

Urban forestry aims at bringing trees to the doors of the urban people. Broadly speaking, this concept lays emphasis on the aesthetic development of urban areas. Flower and fruit trees of ornamental variety which flower and fruit at different seasons, are planted along road sides and canal banks near towns, villages and cities. Urban forestry also envisages beautification of private compounds, roads and vacant lands as also creation of tree reserves, in towns and cities. Borivali park in Bombay, Kukrail forest in Lucknow and Banargatta park in Bangalore offer illustrations of such achievements. These parks serve as urban health resorts and are extremely popular with the town dwellers.

In Gujarat, some interesting and unique forestry conventions, have been created. There, every residential compound is to have a minimum of five trees. This is obligatory before approval of the map and permission to construct the building are accorded. Felling of trees is banned. Even the road alignment is invariably changed to avoid felling of trees. All social ceremonies conducted by the Governor, Ministers or V.I.P.s must be preceded by tree planting rituals. Religious ceremonies such as Kathas etc., must be marked by planting trees. Similar conventions need to be established throughout the country.

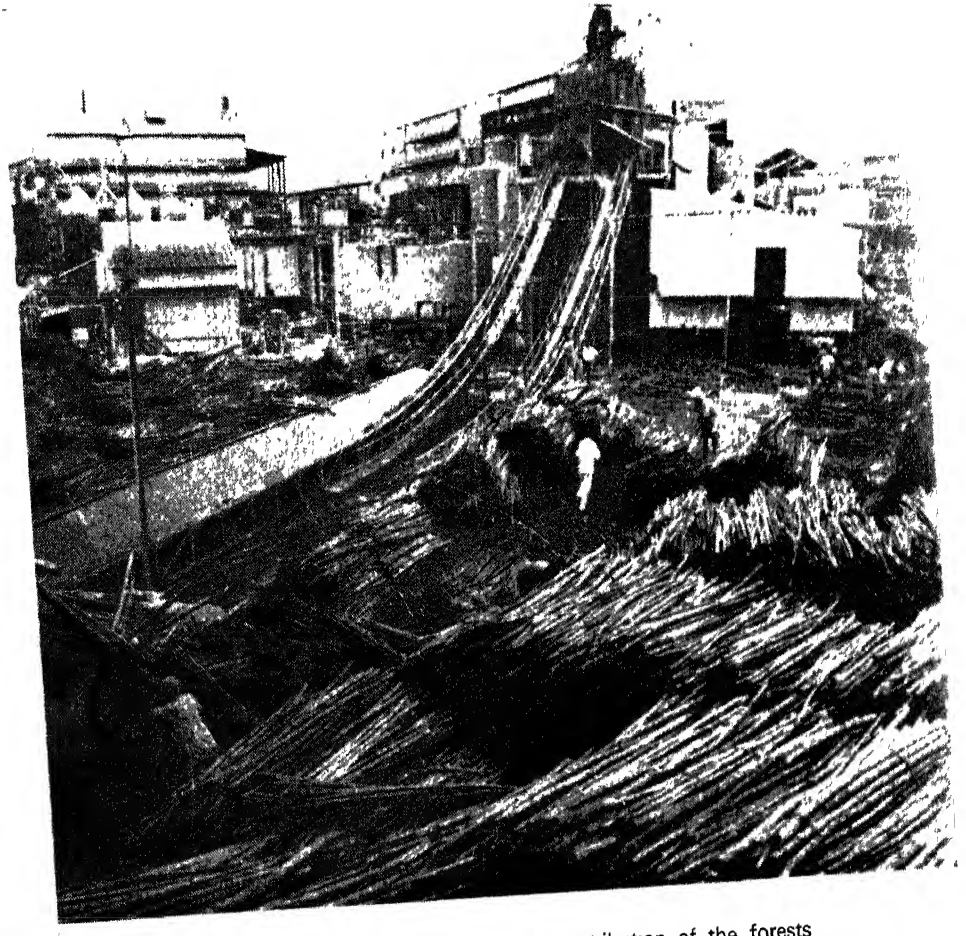
Pilot projects on social forestry

Gujarat State has adopted social forestry in a big way. Tree consciousness has been culturally fostered. Important social ceremonies such as marriage and religious functions like thread ceremony are preceded by tree planting.

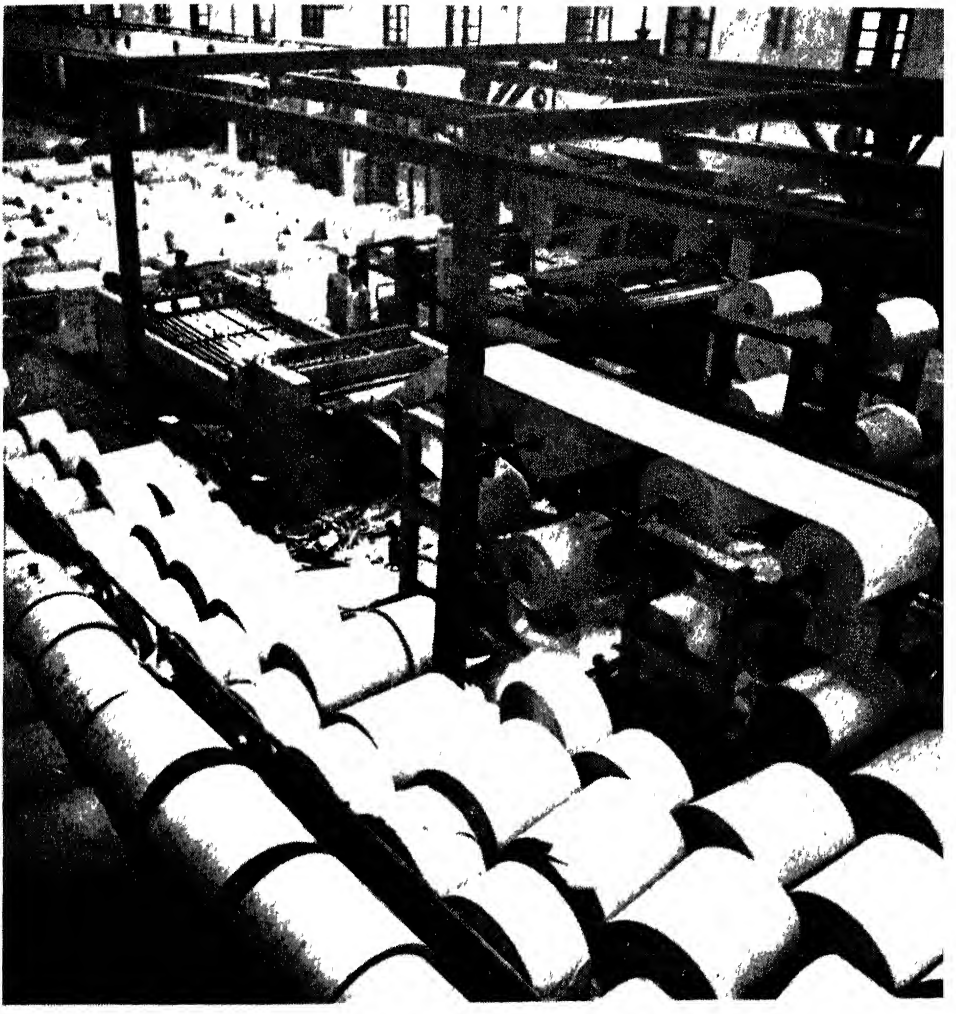
To lend impetus to tree planting, a leading Kathakar has offered to recite Mahabharat katha free of charge if any farm owner planted 500 trees. The Mahabharat katha lasts for about 5-6 days. His offer has prompted many a farmer to plant trees. Social organisations, such as, Sad Vichar Parivar, Friends of Trees and Y.M.C.A., have also undertaken tree planting on a large scale. These activities have created tree consciousness among the people and a genuine urge to turn their surroundings green.

Many educational institutions, schools, colleges, universities, polytechnics, etc., have created Vidyarthi Vans on vacant land in and around their institutions. Worth mentioning here are the urban forestry (beautification) programmes executed in spare time by the students of the Government Polytechnic for Girls, Gujarat University and St. Xavier's College, Ahmedabad. The Forest Department has introduced schemes for raising nursery plants through voluntary efforts of school children. The enterprise does not clash with normal school activities. In 1977, 54 schools scattered in eight districts of Gujarat raised 4,66,500 seedlings. During the year 1978, 84 schools pursued this

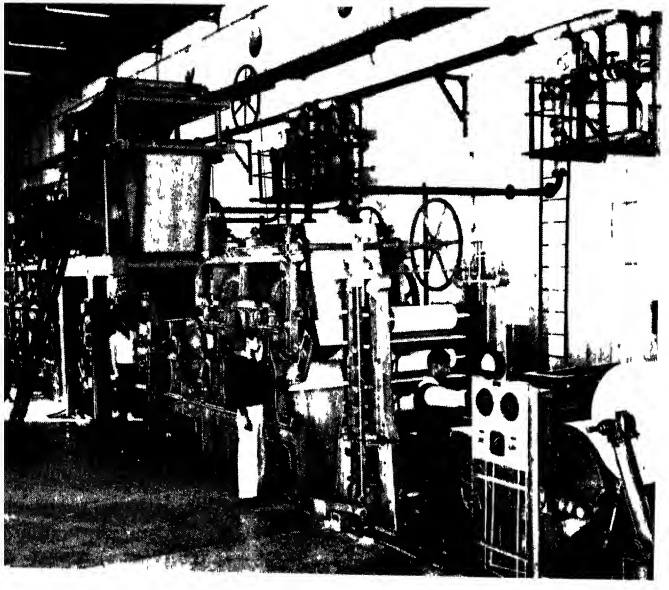
Wood being transported on water.



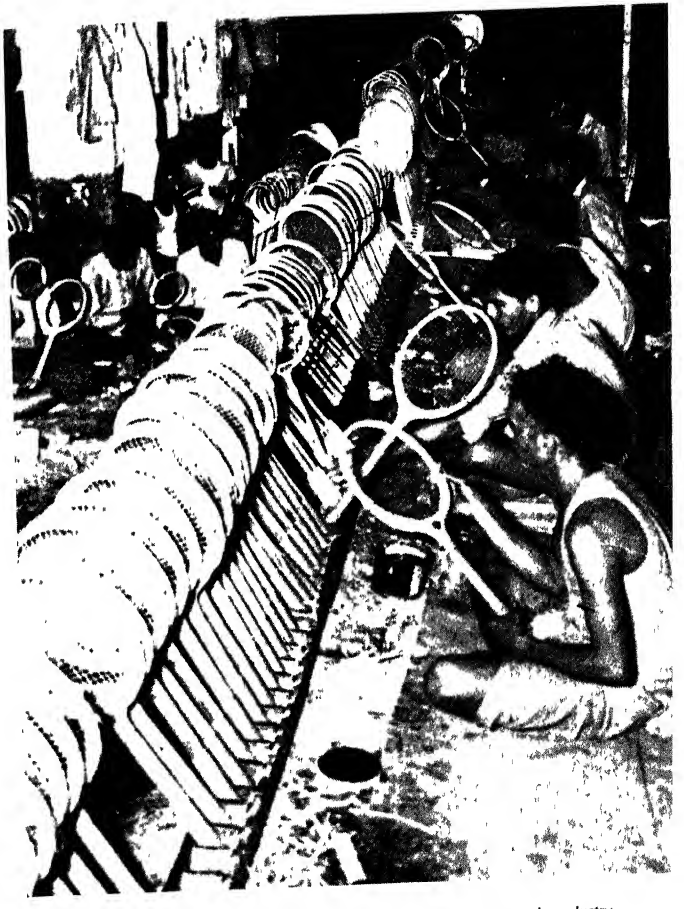
Paper is perhaps the most important contribution of the forests to modern civilisation. Bamboo being fed into a paper mill ..



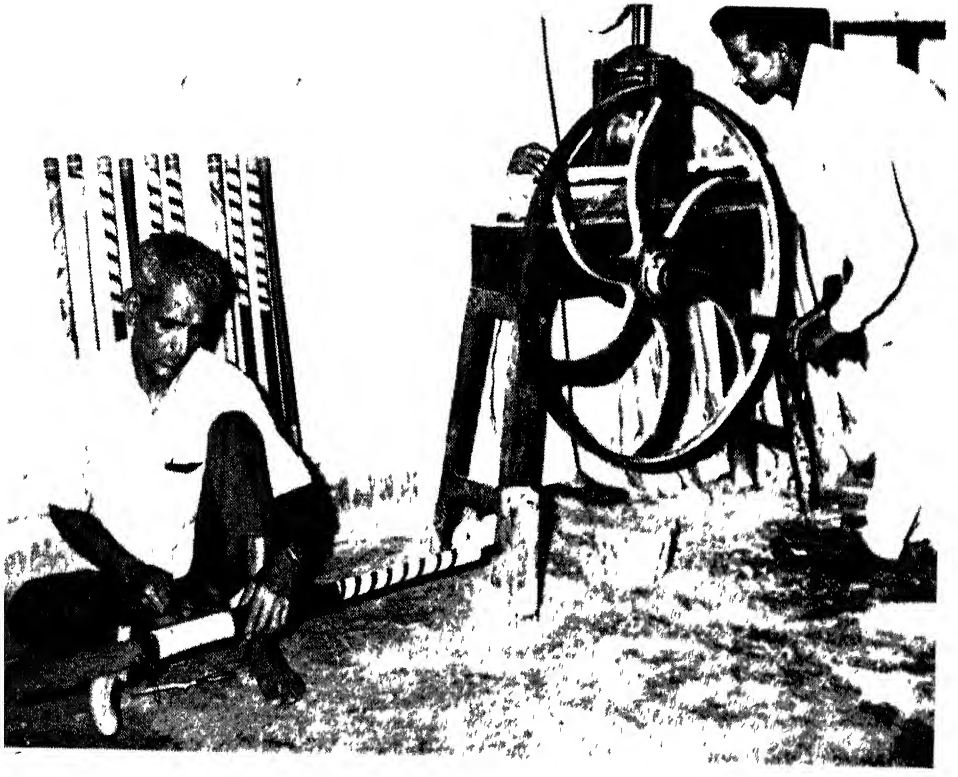
...which is turned into rolls of paper.



A paper plant



Wood is an important raw material for the sports goods industry
—tennis rackets being made out of ash wood



Hockey sticks being made from mulberry.

Dioscorea deltoids—a medicinal herb. Roots of the plant are used to synthesise essential steriodal products.

Forests also supply raw materials for some of the cottage industries. Women manufacturing match boxes.

programme. Seeds, polythene bags, etc., are provided by the Forest Department and the ensuing seedlings are later purchased by it at a nominal rate of 15 paisa per seedling. The money thus raised is utilised for giving aid to the poor children, purchase of books, sight seeing excursions by students, etc. The socio-economic impact of this activity is more than meets the eye. Through this activity the Forest Department is inculcating among the citizens of tomorrow tree consciousness and the glory of green revolution. If each student plants ten seedlings a year, a total of over 770.5 million seedlings can be raised annually in the country.

SOCIAL FORESTRY AND OWNERSHIP CONCEPT

Unless the trees raised in social forestry are protected for at least 4-5 years or till the plants are established, no benefit would accrue from the same. The level of benefit rises with the healthy growth of trees as a result of care and maintenance. The farmers who tend their trees systematically receive a much higher return from their trees than from any other form of fair market investment. The ownership or property rights are important for conservation of the resources created under social forestry. The property right should be regarded as an instrument to make the self interest of individuals serve the welfare of the society. In social forestry we are dealing with areas having varying mixtures of public/communal/private ownership of land. The protection of each area and its vegetation cover depends mainly on the ownership rights as perceived by the individual and the rural masses. Property rights are well defined in the case of private farms and public lands. However, in the case of the latter, protection is comparatively difficult. Whereas the individual owner can always protect the crop in his private land, protection of trees on lands belonging to village panchayats, the Railways, P.W.D., the Irrigation Department etc. is difficult primarily because everyone's property is no one's property. Therefore, unless exclusive rights over the trees are given to

individuals such as we do for lease of public land for taungya, agri-silviculture, etc., the protection of trees in all these categories of lands will always remain a problem. In the case of agriculture land, since the ownership is well defined and no protection problem exists, the survival of trees and the return per unit area is high.

One way to protect the trees, particularly on the road side plantations is to allot a number of trees to some individual living close by. And, those who protect the tree should also be allowed to share the benefits. In the case of fruit, flower and seed trees, the annual produce should be given free of cost or at nominal cost to those who protect them. In addition, the protector should also be given a share from the final felling of the trees. Advance publicity of the distribution pattern of benefits likely to accrue will foster security of ownership so essential for the long term protection of trees. This ownership concept will induce the owner to regard each tree as a self growing factory, needing only the protection inputs from the owner. While the question of organising tree protection brigades (Van Rakshak Dals), societies of tree lovers, Sad Vichar Samitis and appointment of honorary tree wardens may be useful in the urban areas, some positive economic incentives, as proposed above, are essential for the rural areas to ensure effective protection of trees. There is also an urgent need for analysing and modifying the land tenure systems to accommodate the needs of social forestry.

Social forestry is meant to bring a social change, to ameliorate distortions in the economy and to ensure a more equitable distribution of income.

We have, therefore, to evolve new criteria for assessment of social forestry projects and go beyond the traditional cost-benefit ratios. For example, the indices for comparing different farm forestry projects could be (i) their employment promotion potential, (ii) extent of release of cowdung from hearth to field as manure, (iii) structural timber and firewood resources created annually, (iv) availability of fodder, fruits, seeds, bamboos

and canes, and total income from these sources on an yearly unit area basis. The impact of each programme on these indices can be found by comparing two situations, (i) farms/villages without forest trees, and (ii) farms/villages with forest trees.

At the microlevel of planning, the social forestry programme should define as to how forestry can help the rural development activities particularly in regard to (i) wood fuel and timber uses, (in case charcoal is manufactured, it should be done in closed stills so that the ensuing gases etc. are recovered), (ii) fodder, (iii) leaf manure, and (iv) forest and wood products based cottage industries. Social forestry programmes should also be concerned with, (i) analysing the land tenure systems affecting the conservation of tree resources created under social forestry and an equitable distribution of the gains therefrom, and (ii) identifying village leaders and fixing target groups of the rural population to be trained in social forestry practices and determining the course contents of training programmes.

For the success of the social forestry programmes, the attitude of the forester, villager, politician, decision maker and all those involved with the creation, maintenance and utilisation of the natural resources, must change. It may also need some institutional changes in education, training and motivation of the rural masses, research and administration. While talking of integrated land use, leading to the joint production of basic inputs needed for human existence and survival, the Chinese experience becomes relevant to us. The results produced by the Chinese in their efforts to create legendary shelter and wind belts and the success attained by them in mitigating floods tell volumes, on how mass manpower can be used to attack social problems in a compressed time frame. In India too identical achievements are possible only if all land development plans integrate social forestry as one of its essential components.

Chapter XIII

HOW TO RAISE TREES

There are three methods of planting trees—direct sowing, transplanting and planting of stumps or cuttings.

Direct sowing: Some species can be raised by sowing seeds directly in the ground. For direct sowing, soil working has to be done well before the sowing season and the dug up earth allowed to aerate for several weeks before being filled back in trenches or pits prior to sowing. The sowing of seeds can be done at any time from March onwards, if arrangements for irrigation during the summer exist. But normally it is not economically possible to irrigate forest plantations except to a limited extent. The sowings should, therefore, be done 15 to 30 days before the onset of the monsoon, that is, between the middle and the end of May. Sowing can also be done after the monsoon has set in, but pre-monsoon sowings are much better because they allow the seeds a period of preconditioning in the soil and they immediately break out into shoots as soon as the monsoon arrives.

It is very important to use good seed, and arrangements for obtaining an adequate quantity of seed should be made well before the sowing season. It is safer to obtain 20 per cent more seed than the estimated requirements in order to have a sufficient surplus for beating up casualties. All seeds must be pre-treated by soaking in water for at least 24 hours before sowing. The seeds of some species need more drastic

pre-treatment than mere soaking in water such as treatment with weak sulphuric acid solution, boiling water or prolonged soakage in a slurry of cowdung.

Transplanting: While almost all trees can be grown this way, it is often better to sow the seeds in a nursery, and when the seedlings are about 8 to 10 centimetres high to transplant them into polythene bags filled with a mixture of soil, sand and farmyard manure in equal quantities. These polythene bag plants are kept in the nursery for three to nine months, well watered and looked after till the seedlings attain a height of 50 to 100 centimetres. These plants are then ready for planting out in the field in properly prepared pits. This is known as entire 'transplanting'. This method is more costly than direct sowings but gives a much higher percentage of success because the young plant gets good care for the first 3 to 9 months of its life in the nursery and is much sturdier.

Stump and branch cuttings: The third method is through planting of cuttings or stumps. This method consists of growing seedlings in nursery beds and when their stems are about the thickness of your thumb, the seedlings are pulled out of the nursery bed after the bed has been well watered so that in pulling out least damage is caused to the fine roots. Thereafter stumps are prepared from the seedlings by cutting at it both ends about five centimetres (or the length of your thumb) above the 'collar' (that is the ground line) and about 20 centimetres (or the length of one span of your hand) of the root below the collar. These stumps are then taken to the field and planted in holes prepared with a crow-bar in the centre of each planting pit and the soil firmly consolidated. Another variation of this method is the use of branch cuttings. Some species of trees can take root easily if cuttings about 20 to 25 centimetres long prepared from thin branches not exceeding the thickness of your thumb in diameter are planted in the pits. Raising plantations through stumps and cuttings is cheaper than entire transplanting but it

can succeed only for certain species such as mulberry, shisham, teak, sanjana (drum stick) and semul.

Nursery practice: Nurseries should be laid out where the soil is good and irrigation is available. The soil should be well ploughed and worked and then divided into nursery beds 12 metres long and 1.2 metres wide with a gap of 60 centimetres between beds. Irrigation channels should be laid to all the nursery beds. The soil in the nursery bed should be well worked and manured, and the level of the bed should be raised by about 15 centimetres above the surrounding level. Sowing of seeds in nursery beds can be taken up immediately after the rains are over in October, and can continue up to the end of November. Thereafter, no further sowing should be done during the cold months of December and January and the first half of February. From the middle of February onwards sowings can be resumed and continued till April or May. Care has to be taken to see that all seedlings are kept well watered during the hot summer months. The success or failure of a plantation depends mainly on how well the seedlings have been looked after in the nursery. So this is a very important operation.

Soil working: The next important item is soil working. As in the case of agriculture crops, a good tree crop can be grown only if the soil has been properly worked which means that it is either ploughed or thoroughly broken up with a hoe and then harrowed so that the soil becomes porous and uniform. The soil should be dug well in advance of the planting season so that it is allowed to aerate for at least one or two months.

For planting trees individually or in single or multiple rows the most suitable type of soil working would be to dig pits 60 cm. x 60 cm. x 60 cm. Allow the soil to aerate and then put it back into the pits along with some manure about the end of June or early July. Planting of entire transplants, stumps or cuttings should be done about the middle of July after the rains have definitely set in.

Weeding, maintenance and protection: Throughout the rainy season the plantation should be kept well weeded. An area of about 50 cm radius around the base of each plant should be kept clear of grasses and weeds. Irrigation is not necessary if the rains are good, but in the case of an unusually long break in the monsoon, the plants should be watered wherever possible. This is particularly necessary in the case of single plant or those planted in rows along roads, canals, etc. Watering of plants during the following summer would be necessary particularly if there has been a shortage of winter rains.

The most important item is protection. The young plant is to be protected from damage by animals. For large areas of block plantation, the most economical method is a barbed wire. The cost may be high but to ensure success of the plantation this is the most economical solution. For trees planted singly or in rows, digging of circular trenches about 1.5 to 2 metres in radius around each plant would be desirable. These trenches should be 90 cm wide and 90 cm deep and the dug-up earth should be piled along the outer edge of the trench. Such a trench will effectively prevent browsing by cattle. Other methods of protection are using thorns and brush-wood as a fence. These are cheap but not lasting and have to be kept repaired.

It must be emphasised that subsequent maintenance and protection of the plants is far more important than mere sowing and planting. It is estimated that only 30 per cent of the total effort and expenditure on raising a tree is on soil working and planting, and the balance 70 per cent is required for subsequent maintenance and protection. So it must be ensured that all plants are given complete protection for at least the first three years of their life. If all operations have been properly carried out and adequate protection given, the plants should have grown sufficiently strong and high to need no further protection except from deliberate damage by human beings.

Chapter XIV

A LEGACY FOR POSTERITY

Deforestation and denudation in our country has already reached a serious stage. Unless the forces and tendencies which are responsible for destroying the country's environment are checked in the near future and afforestation of denuded areas taken up on a massive scale, the harshness of the climatic conditions and soil erosion by wind and water will increase to such an extent that agriculture which is the mainstay of our people, will gradually become impossible. The desert countries of the world and our own desert areas in Rajasthan are a grim reminder of the consequences of large scale deforestation. The Rajasthan desert is already on the march and is spreading into the adjoining States of Punjab, Haryana and Uttar Pradesh. Pockets of desert are appearing in other parts of the country including the Himalayan region and the Deccan plateau. Where only a few decades back there used to be lush green forests with perennial streams and springs, there is only brown earth, bare of vegetation, without any water in the streams and springs except in the rainy season. The ground water level is also falling noticeably.

What the country needs is to be clothed with greenery so as to bring back to the land the benefits of a good climate, abundant water supply and prosperous agriculture. This can be achieved only through the cooperation of the people particularly those living in the rural areas and in the vicinity of the forest. Deforestation and haphazard cutting of trees must be stopped.

It does not mean that no trees should be felled. It only means that no trees should be felled haphazardly and before they have reached maturity. It also means that for every tree felled at least two should be planted in replacement so that the continued existence of the tree wealth is maintained. The popular belief that trees and forests grow by themselves and have been created by Nature only to be felled by man whenever he desires, has to be erased from the public mind. A love for trees and forests has to be created, and people have to be made conscious of the very important fact that the forest is a crop, which like all crops, requires to be carefully husbanded and harvested at the proper time if it is required to yield its benefits, both direct and indirect, on a sustained basis. It must be realised by the present that the trees they are felling for their use are not of their earning but that of the previous generations. The present generation owes it to the generations coming after them to leave behind a similar heritage. A seedling planted today will require love and care from the present generation in order that their descendants reap the benefit.

This kind of philosophy has to be inculcated among our people from childhood. It is amazing that the love of forests and trees and the care that they should receive has been preached by our ancient saints and poets in our religious texts, thousands of years back when most of India was covered with thick forests. Yet our sages were so wise that they foresaw the seeds of destruction even in the comparatively minor intrusion of agriculture into forest lands. The edict on the Ashoka pillar near Kalsi in Dehradun district exhorts people to protect forests and wildlife—this at a time when all that area must have been one vast forest teeming with wild animals. In all Hindu religious ceremonies, amongst the various Devatas to whom homage is paid, the Vana Devata has a prominant place. In her marriage vows, the bride makes the bridegroom promise that he will take her advice when he plants a tree or a grove. The ficus trees such as the peepal and the banyan have been accorded religious sanctity and total protection because they provide

shade to human beings and refuge and food to millions of birds. Felling them in the green condition is considered a sin. So is the felling of green fruit trees such as the mango. It is unfortunate, that today selfishness and greed over-ride all these religious considerations and felling of ficus trees and green mango trees goes on apace.

The reclothing of vast tracks of bare land with vegetation and the greening of India lies in the hands of the people. While the forest Department all over the country is doing its utmost to conserve the forests under its control and to take up afforestation on a scale unheard of before, no one single Government agency or even a group of agencies can successfully accomplish this gigantic task. In the ultimate analysis it is only the people of India—men, women and children—who can help in making our country green and prosperous. The Vanamahotsava festival has done much to arouse public interest in tree planting but unfortunately, the results are not commensurate with the publicity given to the numerous tree planting ceremonies that take place every year. The reason is the lack of after care needed to nurse the trees after the fan-fare of the tree planting ceremonies is over Too much emphasis is laid on the act of placing a seedling in the ground by some VIP and too little on ensuring that the little seedling grows into a tree. If the amount of money spent on garlands, photographs and documentary films to cover ceremonies is totalled up over the years it would amount to a formidable figure. This amount could have been better spent on providing tree guards or barbed wire fencing and a little watering during the dry season. Public consciousness has to be aroused for celebrating Vanamahotsava in the true sense which means less of pomp and ceremonial and more of solid good effort to see that the ceremony does not begin and end with the planting of a seedling but also ensures that care of every seedling planted.

As noted earlier, there are about 43 million hectares of land in our country which are classed as uncultivated, non-agricultural or barren. In addition, there are large areas of

degraded forests amounting to over seven million hectares. Thus 50 million hectares of land are available for afforestation. Then there are other idle land resources along road sides, rail tracks, canal banks, drainage channels and inside the compounds of public buildings, schools, colleges and hospitals. All this available land needs to be afforested in a purposeful manner and within a short time frame. This can be achieved through a massive social forestry programme adopted and implemented by the people.

It is important that school children should be taught early to love and respect forests and trees, and that they should learn how to raise and protect them. All schools, specially in the villages, should start nurseries where the children raise seedlings of timber, fuel and fruit trees. The sale of the seedlings could bring in a welcome revenue to the schools for the benefit of the children. But the greatest benefit will be the love of trees that will be inculcated among them from an early age. The children who plant trees today will not destroy them tomorrow or allow others to do so. Because what is more important than afforestation and planting of trees is the protection of the existing tree growth from the insane destruction that is taking place all over the country.

"He who planteth a tree is a man of God
for he renders service to many generations
and faces that have not seen him all shall bless him."

Appendix I

FOREST AREA [1980-81]

(Area in '000 hectares)

State/Union Territory	Area
STATES :	
Andhra Pradesh	6397.1
Assam	3078.8
Bihar	2923.2
Gujarat	1965.6
Haryana	166.9
Himachal Pradesh	2119.0
Jammu & Kashmir	2103.7
Karnataka	3833.4
Kerala	1125.1
Madhya Pradesh	15541.4
Maharashtra	6396.6
Manipur	1515.4
Meghalaya	947.7
Nagaland	287.6
Orissa	6022.4
Punjab	260.2
Rajasthan	3448.2
Sikkim	282.0
Tamil Nadu	2179.1
Tripura	592.2
Uttar Pradesh	5114.9
West Bengal	1183.0
Total	67475.3
UNION TERRITORIES :	
A & N Islands	714.4
Arunachal Pradesh	5154.0
Dadra & Nagar Haveli	19.9
Delhi	
Goa, Daman & Diu	105.3
Mizoram	1593.5
Total	7587.1
ALL INDIA	75062.4

Appendix-II

TREE SPECIES RECOMMENDED FOR PROPAGATION UNDER SOCIAL FORESTRY PROGRAMMES*

(Versatile uses of the wood, leaves, root, bark, flowers, fruits, seeds of each species are also indicated)

Sl. No.	Scientifc Name	Trade/ Common Name	Climatic Zone	Utilization Pattern										
				Industrial Timber	Small timber Poles	Fuel wood	Fodder feed, leaf/pods	Edible fruits	Oil bearing seeds/wood/leaves	Gum	Tanin	Shade/ornamental	Soil Conservation stabilization	Medicinal value: Flower F. Leaf.-L. Seed-S, Bark-B, Gum-G Root-R Fruit-Fr, Dry Flower-DF Plant-P, Wood-W, Oil-O, Decoet of Bark-DB, Decoet of Leaves-DL, Root Bark-RB
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Acacia modesta	Phulai	Sub tropical		x	x				x	x		x	G.
2	Acacia senegal	Kunta	Dry tropical		x	x				x	x		x	G.
3	Acacia cupressiformis		Dry tropical		x	x	x			x	x		x	B, G.
4	Acacia nilotica spp,	Babul	Dry tropical			x	x						x	B.

*Annexure I to Social Forestry on a Cost-Benefit Analysis Framework by B.P. Srivastava and M.M. Pant, Indian Forester Vol. 105, No. 1, January 1979.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
5	Acacia catechu	Khair	Dry and Moist tropical	x	x	x					x		x	B, L.
5A	Acacia chundra	Lal khair	Dry tropical	x	x	x					x		x	B.
6	Acacia radiana	Vilayatai kikar	Dry tropical		x	x					x		x	B
7	Acacia alurina	Pahari kikar	Dry tropical		x	x					x		x	B.
8	Acacia auriculiformis	Sonajhuri	Dry and Moist tropical		x	x					x		x	B, G.
9	Aegle marmelos	Bael	Dry tropical			x		x	x	x	x	x	x	F, R.
10	Aesculus indica	Horse-chestnut	Temperate, Sub tropical		x		x	x	x			x	x	F, B, O
11	Ailanthus excelsa	Maharukh	Tropical moist Dry tropical											
12	Albizia lebbeck	Kokko	Dry and Moist tropical		x		x				x	x	x	P, B, S, R, L.
13	Albizia procera	Safed siris	Tropical moist	x	x							x	x	L
14	Alnus nitida	Arder	Temperate		x						x	x	x	
15	Alnus nepalensis	Arder	Temperate, Sub tropical		x						x	x	x	B.
16	Anacardium occidentale	Cashew	Dry tropical Coastal		x	x		x	x			x	x	B, R, F.
17	Artocarpus species	Kathal	Tropical moist		x			x			x	x	x	L. R Flower
18	Artocarpus lakoocha	Lakooch	Tropical moist											
19	Arundo-donax	Baranal	Sub tropical	x								x	x	Rhizomes
20	Azadirachta indica	Neem	Dry and Moist tropical	x	x		x		x	x		x	x	B. L, G, D, F,

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
21	Bauhinia chinensis	Kanchan (Kachnar)	Sub tropical, Tropical											P.
22	Bauhinia retusa	,,	Sub tropical, Tropical		x		x			x		x	x	P. G.
23	Bauhinia species	,	Sub tropical, Tropical		x		x			x		x	x	E, P, G, S, L
24	Boswellia serrata	Salai	Dry tropical	x	x	x				x		x	x	G.
25	Cassia siamea	Rajbrikh	Tropical moist	x		x					x	x	x	L.
26	Cassia fistula	Amaltas	Tropical moist			x					x	x	x	Fr, RB, F, L, R.
27	Cassia auriculgta	Tarwar	Tropical moist		x		x				x	x	x	B, R, L, F, S.
28	Casuarina equisetifolia	Casuarina	Tropical moist and Coastal region	x	x	x	x		x			x	x	B, DL.
29	Castanopsis species	Chest nut	Temperate	x							x	x	x	S.
30	Castanea sativa	Sweet Chestnut	Sub tropical	x			x	x			x	x	x	L.
31	Celtis australis	Celtis	Temperate, Sub tropical	x	x	x	x	x				x	x	F, S
32	Cornus oblonga	Indian cornel	Sub tropical	x	x							x	x	
33	Corylus colurna	Bhotiaba-dam	Temperate					x				x	x	Nuts
34	Cordia dichotoma	Lasora	Dry tropical	x			x	x			x	x	x	F, B, L, D.B.
35	Cordia rothii	Lasora	Dry tropical	x	x							x	x	DB
36	Cupressus torulosa	Cypress	Temperate, sub tropical	x	x				x			x	x	
37	Cupressus cashmeriana	Cypress	Temperate, Sub tropical		x							x	x	Tubers

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
38	Dalbergia sissoo	Sissoo	Tropical moist	x	x	x	x			x	x	x	x	L, R, W.
39	Dalbergia latifolia	Rosewood	Tropical moist	x	x						x	x	x	P.
40	Dendrocalamus strictus.	Bamboo	Dry tropical, Tropical moist	x	x		x	x		x			x	L.
41	Duabanga sonneratioides	Lampati	Sub tropical, Tropical moist	x	x			x				x	x	G.
42	Eucalyptus camaldulensis	Eucalyptus	Dry and moist tropical	x					x	x	x	x	x	
43	Eucalyptus species	Eucalyptus	Temperate, Sub tropical, Dry & Moist tropical	x	x	x			x	x	x	x	x	L, R.
44	Emblica officinalis	Amla	Moist & Dry tropical		x	x	x		x		x	x	x	F, R, S, Flower
45	Ficus species	Figs	Sub. Dry and Moist tropical				x		x			x	x	L, B, S, R, F.
46	Ficus glomerata	Gular	Sub tropical		x		x	x				x	x	B, R, L, F
47	Grevillea robusta	Silver oak	Sub tropical		x	x	x			x	x	x	x	
48	Grewia optiva	Dhaman	Temperate, Sub tropical		x		x				x	x	x	
49	Omelina arborea	Gamari	Tropical moist	x	x	x	x					x	x	L, P.
50	Holoptelea integrifolia	Kanju	Tropical, Moist, and Dry tropical	x	x	x	x	x	x			x	x	B.
51	Juglans regia	Walnut	Temperate	x			x		x			x	x	B, L, F.
52	Kydia calycina	Pula	Tropical moist	x	x	x	x			x		x	x	L.
53	Lawsonia alba	Henna	Dry tropical		x						x	x	x	B, L, DL Flower

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
54	Litchi chinensis	Benthal	Sub tropical					x				x	x	F, L.
55	Lagerstroemia spp.	Benteak	Tropical moist	x	x	x	x			x	x	x	x	
56	Leucena leucopephala	Tiora kadam	Dry Tropical		x	x						x	x	B Plant
57	Madhuca latifolia	Mahua	Dry tropical	x		x	x	x	x			x	x	B, S, Flower
58	Mangifera indica	Mango	Sub tropical, Tropical	x	x		x	x		x		x	x	L, F, S, B.
59	Mesua ferrea	Mesua	Tropical moist	x	x	x		x	x	x	x	x	x	F, B, Unripe Fr.
60	Melia azaderach	Bakain (Persian-lilac)	Tropical moist, Dry tropical	x	x	x	x		x		x	x	x	DL, B, L.
61	Michelia oblonga	Champ	Sub tropical	x	x	x						x	x	B, RB, F. Fr.
62	Michelia excelsa	Champ	Sub tropical	x	x							x	x	B, F.
63	Mitragyana parviflora	Kaim	Moist tropical	x	x		x			x	x	x	x	B, R
64	Morus laevigota	Bola	Sub tropical	x	x		x	x				x	x	
65	Morus serrata	Mulberry	,,	x	x		x					x	x	
66	Morus alba	Mulberry	Tropical moist	x	x		x	x			x	x	x	
67	Parkinsonia aculeata	Vilayati Babul	Dry tropical			x	x	x				x	x	
68	Phoenix dactylifera	Khajur	Dry tropical		x			x				x	x	Fr, S.
69	Pinus gerardiana	Chilgoza Pine	Temperate			x		x		x		x	x	
70	Pinus roxburghii	Chir	Sub tropical	x	x		x		x	x	x	x	x	
71	Platanus orientalis	Chinar	Temperate		x							x	x	B, L, R.
72	Planchonella littoralis	Lambapatti	Tropical moist				x					x	x	L.
73	Pongamia pinnata	Karanji	Dry tropical		x	x	x		x			x	x	O, L, RB, B, F.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
74	Poplus alba	Poplar	Sub tropical, temperate	x	x	x	x					x	x	B.
75	Populus ciliata	Poplar	,,	x	x	x	x					x	x	B.
76	Poplus euphratica	Poplar	,,	x	x		x					x	x	B.
77	Poplus nigra	Poplar	,,	x	x	x	x				x	x	x	L.
78	Prosopis chilensia	Vilayati kikar	Dry tropical	x	x					x	x	x	x	
79	Prosopis cineraria	Jhand	,,		x	x	x			x		x	x	W.
80	Prunus persica	Khubani	Temperate		x	x		x	x	x	x	x	x	F, W.
81	Prunus armeniaca	Khubani	,,		x	x		x				x	x	
82	Prunus cerasoides	Paddam	,,					x	x	x	x	x	x	B, Branches
83	Paltoforum pterocarpum	Sejan	Sub, Dry and Moist tropical	x	x		x					x	x	B.
84	Pterygota alata	Narikel	Tropical moist	x	x	x			x			x	x	S.
85	Putranjiva roxburghii	Putrinjiva	Tropical, Sub tropical	x	x		x		x			x	x	L.
86	Quercus floribunda	Indian oak	Temperate	x	x	x	x				x	x	x	S.
87	Quercus glauca	Phaxonj	,,		x	x	x				x	x	x	S.
88	Quercus incana	Banj	,,	x	x	x	x				x	x	x	(acorns)
89	Salix alba	White willow	,,	x	x	x	x				x	x	x	B.
90	Salix babylonica	Weeping Willow	,,	x	x	x	x					x	x	L, B.
91	Salix fragilis	Kashmir willow	,	x	x	x	x					x	x	F, L.
92	Salvadora oleoides	Pikhuva	Dry tropical	x	x	x	x			x	x	x	x	R, F, Fr.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
93	Salmalia insignis (Bombax insigne)	Didu	Tropical moist	x	x	x	x				x	x	x	
94	Salmalia malabarica (Bombax ceiba)	Semul	,,	x	x									
95	Santalum album	Sandal-wood	Dry tropical	x					x			x	x	S, O, W, R, L, Fr.
96	Saraca asoca	Ashok	Tropical, Sub tropical and Dry tropical		x		x					x	x	B, L, F.
97	Schleichera oleosa	Kusum	Tropical	x	x	x		x	x	x	x	x	x	L, B, Fr, Lac, O.
98	Shorea robusta	Sal	Tropical moist	x	x	x			x	x	x	x	x	F, Fr.
99	Spondias pinnata	Amra	Sub-tropical, tropical and Moist tropical	x				x		x		x	x	
100	Spondias mombin spp.	Amra	,,					x				x	x	L, S, Fr.
101	Sterculia urens	Karaya	Dry tropical	x	x	x			x	x	x	x	x	S, B, L, R.
102	Sterculia villosa	Udal	,,	x	x	x		x		x		x	x	
103	Stereospermum personatum	Padri wood	Sub tropical, Tropical moist	x	x		x					x	x	R, L, F, B.
104	Stereospermum suaveolens	Padri wood	,,	x	x	x	x					x	x	F, B, DB.
105	Swietenia mahagoni	Mahogoni	,,	x	x					x	x	x	x	
106	Syzygium cumini	Jamun	Tropical moist	x	x	x	x	x	x		x	x	x	F, Fr.
107	Syzygium jambalana	Jamun	Tropical, Moist					x	x		x	x	x	F, Fr.
108	Tamarindus indica	Imli	Dry tropical	x	x				x	x	x	x	x	L, F.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
109	Tectona grandis	Teak	Dry and Moist tropical	x	x	x	x				x	x		W, S, F, B.
110	Terminalia arjuna	Arjun	Tropical.	x	x	x	x				x	x	x	B, L, Fr.
111	Terminalia bellirica	Bahera.	Tropical moist	x	x	x	x		x	x	x	x	x	Fr, B, W.
112	Terminalia bialata	White chuglam		x	x					x	x	x	x	B.
113	Terminalia tomentosa	Laural	Tropical	x	x			x		x	x	x	x	L, B.
114	Terminalia chebula	Myrabolan wood		x	x					x	x	x	x	B, Fr.
115	Terminalia myriocarpa	Hollock	Tropical moist	x	x	x					x	x	x	B.
116	Terminalia manii	Black chuglam	Tropical moist	x	x	x						x	x	W.
117	Ulmus wallichiana	Elm	Temperate	x	x	x	x					x	x	
118	Vateria indica	Vellapiney	Tropical moist	x	x							x	x	B, Fr.
119	Vitex altissima	Milla	Tropical moist	x	x	x						x	x	
120	Vitex penduncularis	Nagpheni	Tropical moist	x	x	x						x	x	L, B, RB.
121	Vitex pinnata	Nagpheni	Tropical moist, Tropical	x	x							x	x	B, L, DB.
122	Xylia Xylocarpa	Irul	Tropical			x		x				x	x	Dect, B, O.
123	ziziphus jujuba	Ber	Sub tropical	x			x	x			x	x	x	SL, Fr.

Compiled by Shri M.Y. Ansari and M.M. Pant, of the Forest Economics Branch, F.R.I. & Colleges, Dehra Dun.